

TRAK & Sport Bed Mills

Safety, Installation, Maintenance, Service & Parts List Manual

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Covering Machine Models:

- TRAK TRM
- TRAK DPM
- TRAK DPM5
- SPORT B3
- SPORT B5
- TRAK DPMS3
- TRAK DPMS5
- TRAK DPME2

Covering Non-current Control Models:

- ProtoTRAK MX2 & MX3
- TRAK AGE2 & AGE3
- ProtoTRAK M3
- ProtoTRAK SM
- ProtoTRAK EDGE 3



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1.0 Safety

The safe operation of TRAK and Sport Bed mills depends on its proper use and the precautions taken by each operator.

- Read and study this manual and your model's corresponding Programming, Operating, and Care Manual. Be certain every operator understands the operation and safety requirements of this machine *before* its use.
- Always wear safety glasses and safety shoes.
- Always stop the spindle and check to ensure the CNC control is in the stop mode before changing or adjusting the tool or workpiece.
- Never wear gloves, rings, watches, long sleeves, neckties, jewelry, or other loose items when operating or around the machine.
- Use adequate point of operation safeguarding. It is the responsibility of the employer to provide and ensure point of operation safeguarding per OSHA 1910.212 - Milling Machine.

1.1 Safety Publications

Refer to and study the following publications for assistance in enhancing the safe use of this machine.

Safety Requirements for Manual Milling, Drilling, and Boring Machines with or without Automatic Control (ANSI B11.8-2001). Available from The American National Standards Institute, 1819 L Street N.W., Washington D.C. 20036

Concepts And Techniques of Machine Safeguarding (OSHA Publication Number 3067). Available from The Publication Office - O.S.H.A., U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210.

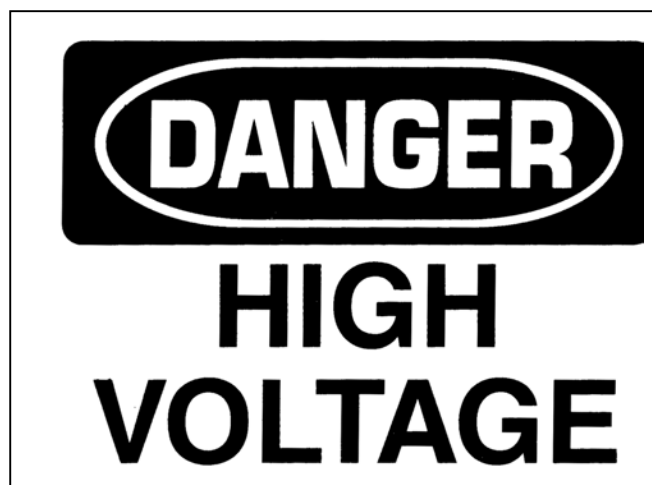
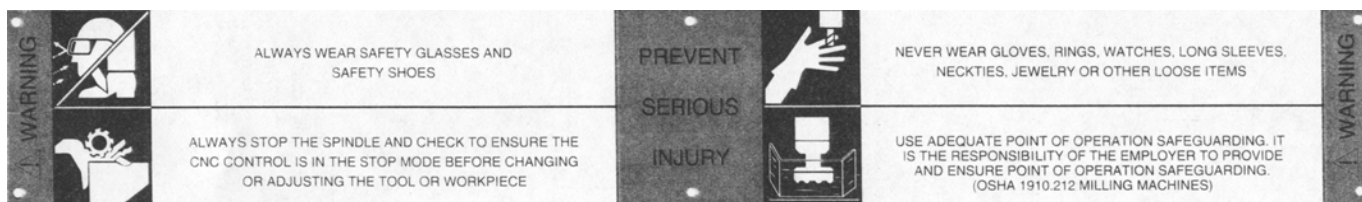
1.2 Danger, Warning, Caution, and Note Labels & Notices As Used In This Manual

DANGER - Immediate hazards that **will** result in severe personal injury or death. Danger labels on the machine are in red.

WARNING - Hazards or unsafe practices that *could* result in severe personal injury and/or damage to the equipment. Warning labels on the machine are in orange.

CAUTION - Hazards or unsafe practices, which *could* result in minor personal injury or equipment/product damage. Caution labels on the machine are in yellow.

NOTE - Call attention to specific issues requiring special attention or understanding.




NOTICE: The manufacture is not liable (responsible) for any damages or injury of any kind to persons or property caused by or resulting from the improper or unauthorized use, operation, maintenance, alteration, modification, change in configuration of this machine or any of its component parts, or the use of this unit with any third party accessories or parts.

.i00775

Safety & Information Labels Used On The TRAK Bed Milling Machines

It is forbidden by OSHA regulations and by law to deface, destroy or remove any of these labels


SOUTH WESTERN INDUSTRIES
 2615 HOMESTEAD PLACE,
 RANCHO DOMINGUEZ, CA 90220

MODEL
 S/N

ELECTRICAL RATINGS:
 VOLTS AMPS PHASE
 Hz

FLA OF LARGEST MOTOR AMPS
 SHORT CIRCUIT INTERRUPT AMPS
 ELECTRICAL DRAWING #:

CNC CONTROL ELECTRICAL RATINGS:
 IF APPLICABLE
 115 VOLTS 8 AMPS 1 PHASE
 60 Hz

MACHINE (ONLY) MADE IN "XXXXXX"

i01158

Power Requirements at 220 and 440 Volts, 3-phase 60 HZ

	DPME2	TRM,	DPM,	DPM5	Sport B3	Sport B5	DPMS3	DPMS5
Overload Setting - 220 V	11 A	8.5 A	8.5 A	14 A	8.5 A	14 A	8.5 A	14 A
Overload Setting - 440 V	n/a	4.25 A	4.25 A	7 A	4.25 A	7 A	4.25 A	7 A
FLA of Largest Motor at 220 V	11 A	8.5 A	8.5 A	14 A	8.5 A	14 A	8.5 A	14 A
FLA of Largest Motor at 440 V	n/a	4.25 A	4.25 A	7 A	4.25 A	7 A	4.25 A	7 A
FLA of Machine at 220 V	11 A	8.5 A	8.5 A	14 A	8.5 A	14 A	8.5 A	14 A
FLA of Machine at 440 V	n/a	4.25 A	4.25 A	7A	4.25 A	7 A	4.25 A	7 A

1.3 Safety Precautions

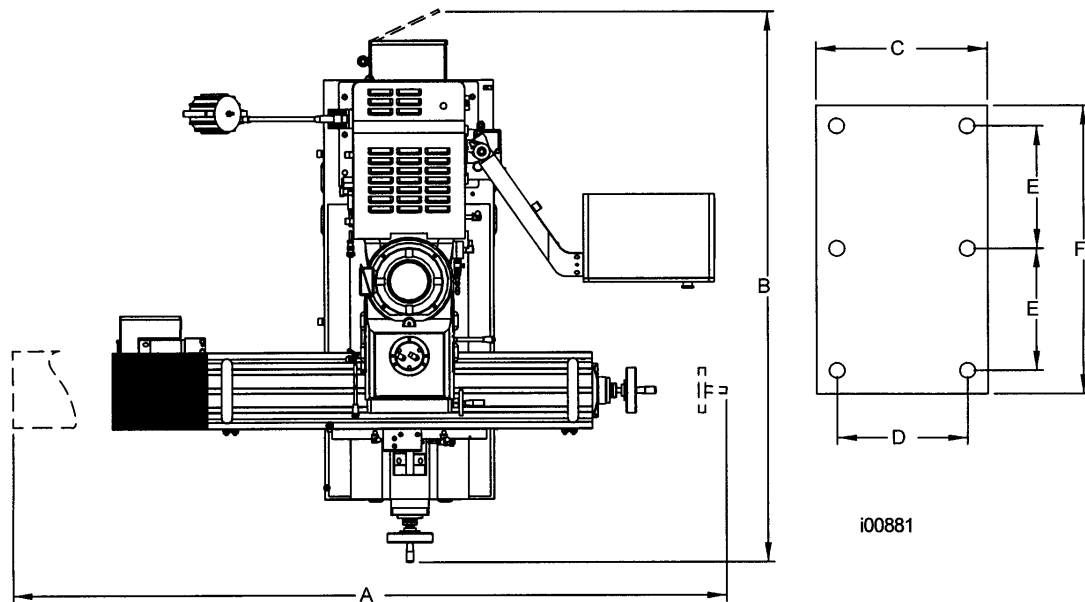
1. Do not operate the machine before this **TRAK Bed and Sport Mills Installation, Maintenance, Service and Parts List Manual** and also your model's corresponding **Programming, Operating & Care Manual** have been studied and understood.
2. Do not run this machine without knowing the function of every control key, button, knob, or handle. Ask your supervisor or a qualified instructor for help when needed.
3. Protect your eyes. Wear approved safety glasses (with side shields) at all times.
4. Don't get caught in moving parts. Before operating this machine remove all jewelry including watches and rings, neckties, and any loose-fitting clothing.
5. Keep your hair away from moving parts. Wear adequate safety headgear.
6. Protect your feet. Wear safety shoes with oil-resistant, anti-skid soles, and steel toes.
7. Take off gloves before you start the machine. Gloves are easily caught in moving parts.
8. Remove all tools (wrenches, chuck keys, etc.) from the machine before you start. Loose items can become dangerous flying projectiles.
9. Never operate a milling machine after consuming alcoholic beverages, or taking strong medication, or while using non-prescription drugs.
10. Protect your hands. Stop the machine spindle and ensure that the CNC control is in the stop mode:
 - Before changing tools
 - Before changing parts
 - Before you clear away the chips, oil or coolant. Always use a chip scraper or brush
 - Before you make an adjustment to the part, fixture, coolant nozzle or take measurements
 - Before you open safeguards (protective shields, etc.). Never reach for the part, tool, or fixture around a safeguard.
11. Protect your eyes and the machine as well. Don't use compressed air to remove the chips or clean the machine.
12. Disconnect power to the machine before you change belts, pulley, and gears.
13. Keep work areas well lighted. Ask for additional light if needed.
14. Do not lean on the machine while it is running.
15. Prevent slippage. Keep the work area dry and clean. Remove the chips, oil, coolant and obstacles of any kind around the machine.

16. Avoid getting pinched in places where the table, saddle or spindle head create "pinch points" while in motion.
17. Securely clamp and properly locate the workpiece in the vise, on the table, or in the fixture. Use stop blocks to prevent objects from flying loose. Use proper holding clamping attachments and position them clear of the tool path.
18. Use correct cutting parameters (speed, feed, depth, and width of cut) in order to prevent tool breakage.
19. Use proper cutting tools for the job. Pay attention to the rotation of the spindle: Left hand tool for counterclockwise rotation of spindle, and right hand tool for clockwise rotation of spindle.
20. After an emergency stop, always turn the FORWARD/REVERSE switch to "Off" (STOP) before releasing or resetting the E-Stop.
21. Prevent damage to the workpiece or the cutting tool. Never start the machine (including the rotation of the spindle) if the tool is in contact with the part.
22. Check the direction (+ or -) of movement of the table, saddle and ram when using the jog or power feed.
23. Don't use dull or damaged cutting tools. They break easily and become airborne. Inspect the sharpness of the edges, and the integrity of cutting tools and their holders. Use proper length for the tool.
24. Large overhang on cutting tools when not required result in accidents and damaged parts.
25. Handwheels must have the crank folded inside when using CNC programmed machining or rapid feeds, power feed or jog.
26. Prevent fires. When machining certain materials (magnesium, etc.) the chips and dust are highly flammable. Obtain special instruction from you supervisor before machining these materials.
27. Prevent fires. Keep flammable materials and fluids away from the machine and hot, flying chips.
28. Changing the speed of rotation of the spindle must be done while the rotation is on. It is recommended to stop and start the spindle at a low rate of speed.
29. Interlocked Table Guards. Interlocked table guards may be purchased from Southwestern Industries, Inc. if deemed necessary by the user.

2.0 Installation

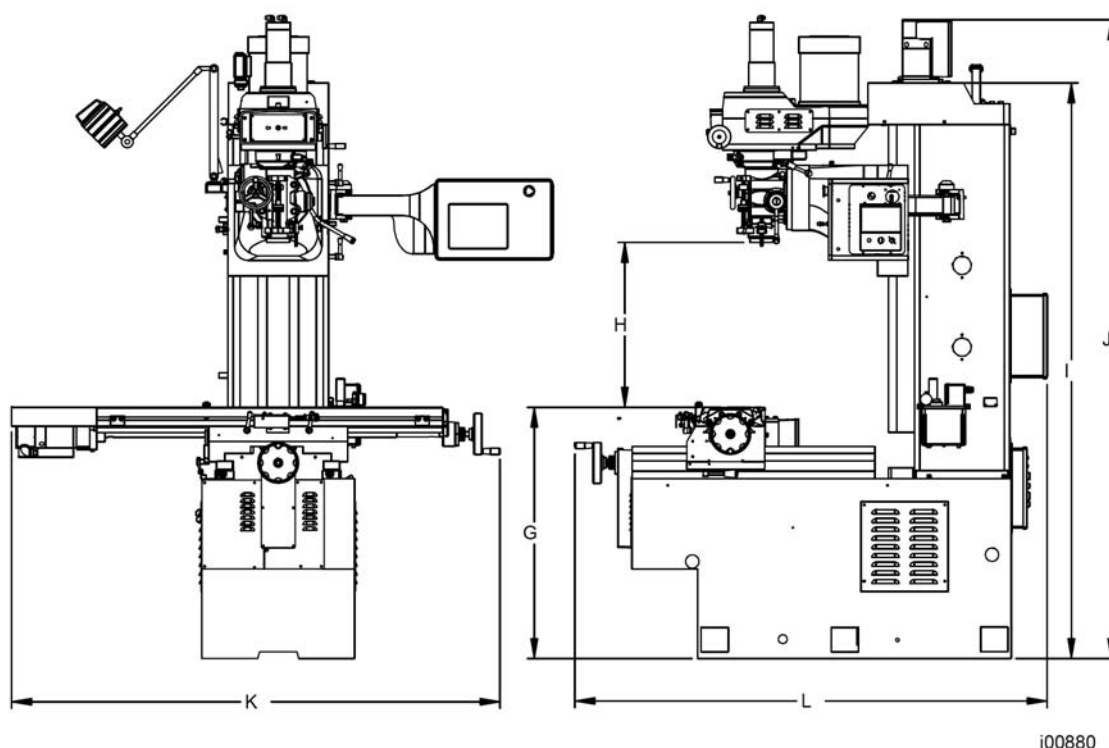
Read and understand this entire installation section before beginning the installation procedure.

2.1 Floor Plan, Layout & Space Requirements – TRAK & Sport Bed Mills



**Figure 2-1
Machine Footprints**

	DPME2	TRM, DPM, Sport B3, DPMS3	DPM5, Sport B5, DPMS5
Footprint of Machine	23.1" x 40.5"	24" x 44"	24" x 48.4"
Weight (approximate) net	3200 lbs.	4100 lb.	4400 lb.
Weight (approximate) shipping	3500 lbs.	4400 lb.	4700 lb.
Pallet Size	70" x 70"	6' x 6'	6' x 6'
A Overall width	101"	108"	136"
B Overall length w/ electric box door open	72"	76"	81"
C Bed width	23.125"	24"	24"
D Bed width between leveling screws	20.5"	21.7"	21.7"
E Distance between leveling screws	32.5"	18.1"	20.5"
F Bed length	40.5"	43.3"	48.4"



**Figure 2-2
Overall Dimensions**

	DPME2	TRM, DPM, Sport B3, DPMS3	DPM5, Sport B5, DPMS5
G Height of table from bottom of bed	34"	38"	41"
H Maximum distance from spindle nose to table	23.5"	23.5"	23.5"
I Maximum height of machine from bottom of bed to top of column cover.	78"	85"	87"
J Height of machine from bottom of bed to top of spindle motor	89"	95"	98"
K Width of machine including table	70"	73"	70"
L Length of machine with electric box door closed	64"	66"	71"

2.2 Uncrating

Carefully remove the wood crate and protective packaging, paying attention not to scratch, damage, or mar any parts of the machine.

Remove the cardboard boxes with the PENDANT DISPLAY (handle carefully), the box containing the TOOL BOX and Z crank. The leveling pads and screws for the machine can be found in the toolbox. The Y way covers are shipped in a separate tube. The lower Z way cover can be found in a box as well.

Remove two steel bars - 1.0 inch in diameter. These items are necessary for lifting and moving the machine.

Loosen and remove 4 screws and nuts holding the machine to the wood pallet.

ATTENTION!

Immediately report, in writing, any damages observed at this time that can be attributed to the transportation or improper handling/moving of the machine.

2.3 Shortages: Inventory Checklist

- _____ Machine (check model and serial number)
- _____ Manual drawbar with washer
- _____ Leveling pads (B239) and screws (B240). Note: 4 each for DPME2 and 6 each for TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, DPMS5
- _____ Table tray with rubber pad (assembled to machine) (TRM, DPM, SPORT B3, DPMS3) (15977)
- _____ Pendant Display with four 1/4-20 screws for mounting
- _____ Pendant Arm assembled to the column
- _____ Toolbox with various tools
- _____ Safety, Operation & Programming Manual for either ProtoTRAK SM, MX, M3, EDGE 3 or TRAK AGE
- _____ TRAK & SPORT BED MILLS Safety, Installation, Maintenance, Service & Parts List Manual (P/N 24941)
- _____ Table trays (DPM5, SPORT B5, DPMS5 only)
- _____ Manual Z-axis crank (16526) (TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, DPMS5)
- _____ Way covers DPME2 – front (23676) and rear (23677) of saddle
- _____ Way covers DPME2 - bottom on column (23675), top on column (23675)
- _____ Way covers TRM, DPM, SPORT B3, DPMS3 – front (B268) and rear (B267) of saddle
- _____ Way covers DPM5, SPORT B5, DPMS5 – front (B268) and rear (B267-1) of saddle

_____ Way covers TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, DPMS5- bottom on column (B202), top on column (B201)

In case of shortages, contact the representative from whom you purchased the machine.

2.4 Installation Instructions & Checklist

Installer: Use this checklist to assure a complete set-up of the TRAK or SPORT BED MILL.

<input type="checkbox"/>	1. Shut off power to the machine.
<input type="checkbox"/>	2. Visually inspect the 220V or 440V wiring going into the electrical panel. Visually verify the wiring is correct per our wiring diagram. Make sure a strain relief is being used where the wiring enters the cabinet. Have the customer repair any wiring discrepancies.
<input type="checkbox"/>	3. Clean the machine if needed and remove any remaining grease.
<input type="checkbox"/>	4. Unlock the table, saddle, and ram gib locks.
<input type="checkbox"/>	5. For DPME2 only, use a 10 mm socket to turn the Z-axis ball screw at the top of the column in order to lower the head until the counterweight is raised off the counterweight support rods.
<input type="checkbox"/>	6. For TRM, DPM, DPM5, Sport B3 & Sport B5, check to ensure that the Z-axis upper way cover spacers are in place to prevent the way cover from getting caught in the Z-axis counterweight chain support sprockets.
<input type="checkbox"/>	7. Using the manual hand crank, lower the head until the counterweight is raised off the counterweight support rods.
<input type="checkbox"/>	8. Remove the two (2) counterweight support rods.
<input type="checkbox"/>	9. Remove the manual Z-axis hand crank. (TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, DPMS5 only)
<input type="checkbox"/>	10. Attach (2) wiper brushes to each table tray using (2) M5 X10 button head cap screws (supplied) per brush. Install (1) table tray on each end of the table (DPM5, SPORT B5, DPMS5 only). NOTE: Ensure that the tray does not scrape the TURCITE. Check TURCITE for damage.
<input type="checkbox"/>	11. Mount the pendant to the pendant arm using (4) 1/4-20 x 3/4" socket head cap screws. For DPME2 only, mount the pendant to the arm using (3) 3/8-16 nuts and lock washer.
<input type="checkbox"/>	12. Make and check all the proper electrical connections from the pendant to the electric box. See the pendant and electric box wiring diagrams.
<input type="checkbox"/>	13. If applicable, load TRAK sensors.
<input type="checkbox"/>	14. Ensure that the 220/440V and, if applicable, the 110V lines are plugged in. Turn on power to machine and pendant.
<input type="checkbox"/>	15. Fill all the head oil cups with SAE 30 oil.
<input type="checkbox"/>	16. Lubricate all the way surfaces and the ball screws.
<input type="checkbox"/>	17. Jog the table, saddle, and ram back and forth until the way surfaces are well lubricated. Oil should be visible on all the way surfaces.
<input type="checkbox"/>	18. Crank the X and Y electronic handwheels to check for functionality.
<input type="checkbox"/>	19. Run the spindle through the high and low gears/speeds and check spindle brakes.
<input type="checkbox"/>	20. Check and use the quill power feed to ensure that it works.
<input type="checkbox"/>	21. Check the level of the machine. The machine should be level to within 0.0005"/10 front to back and 0.0005"/10 side to side. Even though it is the responsibility of the customer, make any necessary adjustments.
<input type="checkbox"/>	22. Check to make sure that the E-Stop button is functioning correctly.
<input type="checkbox"/>	23. Perform Service Code 12, Feed Forward Constant. X- and Y-axis values should be between 2 and 8. Z-axis values should be between 10 and 12. This code must be run any time that a mechanical adjustment or change is made to the machine.
<input type="checkbox"/>	24. Perform Service Code 123 to calibrate the X, Y & Z-axis (quill/ram). Use a 150 mm standard for all axes except use a .75 mm standard for Z quill.

<input type="checkbox"/>	25. Perform Service Code 11 to automatically calculate the backlash for the X and Y-axis of dual feedback machines only (i.e. TRAK sensor or glass scale with a motor encoder).
<input type="checkbox"/>	26. Perform Service Code 127 and 128 to manually calculate the backlash for the X and Y-axis of single feedback machines only (no glass scale or sensor).
<input type="checkbox"/>	27. Check for positional accuracy and repeatability on the X and Y-axis using the machine's relevant test program. Positioning and repeatability values should be within 0.0005".
<input type="checkbox"/>	28. Perform Service Code 100 in both directions for the X, Y, and Z-axis to verify that the feedrate shown on the display is at least 180 ipm.
<input type="checkbox"/>	29. Perform Service Code 97, if necessary, to configure the direction of travel for each axis.
<input type="checkbox"/>	30. Where applicable, perform Service Code 124 to calibrate the Z-axis ram (ball screw). You will need to reinstall the ram manual crank mechanism. Be careful not to jog the Z-axis while the crank is installed.
<input type="checkbox"/>	31. Install the Z-axis upper way cover. Install the Z-axis lower way cover and its bracket.
<input type="checkbox"/>	32. Install the Y-axis front and rear way covers.
<input type="checkbox"/>	33. If machine has an auxiliary function option, use accessory key on pendant and ensure that the coolant pump or solenoid for the mister works. The accessory key should be in the ON position to test coolant pump or solenoid. The control should be in DRO mode. Make sure air is hooked up to the machine during the test. If the machine has a separate coolant pump switch mounted on the pendant arm, turn this on and off to test.
<input type="checkbox"/>	34. If the machine has a power drawbar option, check to ensure that the tools load and unload properly.
<input type="checkbox"/>	35. Cut a Euclid block. Visually inspect the block and make any required machine adjustments. See Euclid block instructions in Section 2.17.
<input type="checkbox"/>	36. Wipe down the machine prior to leaving.

2.5 Machine Specifications

Specifications	DPME2	TRM, DPM, SPORT B3, DPMS3	DPM5, SPORT B5, DPMS5
Table Size	49" x 9"	50" x 10"	50" x 12"
T-Slots (number x width x pitch)	3 x 16 mm x 64mm	3 x 16 mm x 64 mm	3 x 16 mm x 64 mm
Travel (X, Y, Z axis)	31 x 16 x 23.5"	31 x 17 x 23.5"	40 x 20 x 23.5"
Quill Diameter	86 mm	100 mm	100 mm
Spindle Taper	R8	#40 taper	#40 taper
Spindle Speed Range	Low 60-600 High 550-5000	70 – 4200 RPM	70 – 3950 RPM
Spindle Nose to Table (max part height)	23.5"	23.5"	23.5"
Spindle Center to Column Face	18"	19"	20"
Spindle Motor Power	3 HP	3 HP	5 HP
Voltage	220 V	220/440 V	220/440 V
Phase/Cycle	3-phase/60Hz	3-phase/60 Hz	3-phase/60 Hz
Current (Full load amps)	8.5 FLA	8.5/4.25 FLA	14/7 FLA
Machine Net Weight/Shipping Weight	3200 lbs/3500 lbs	4100 lbs/4400 lbs	4400 lbs/4600 lbs
Maximum Weight of Workpiece	1320 lbs	1320 lbs	1760 lbs

2.6 Maximum Work Capacities

	DPME2	TRM, DPM, SPORT B3, DPMS3	DPM5, SPORT B5, DPMS5
Drilling Mild Steel	1"	1"	1"
Tapping Mild Steel	.75"	1"	1"
Milling (metal removal rate/mild steel)	2 inch ³ /min	3 inch ³ /min	5 inch ³ /min

Maximum work capacities are dependent on a lot of variables that cannot be controlled by the machine manufacturer. Each one of the following will have an impact on the above numbers: speeds, feeds, cutter, cutter sharpness, material, setup, coolant and machine adjustments. The numbers above assume all conditions are optimal and may be higher or lower depending on material composition.

2.7 Control Hardware

2.7.1 TRAK AGE & ProtoTRAK MX Controls – TRM & DPM (DPM5 – AGE only)

- Digital Servo Amplifiers custom designed for ProtoTRAK AGE 2/AGE 3 operation.
- D.C. Servo Motors rated at 280 in-oz. continuous torque for X and Y, and 560 in-oz for Z.
- Ball screws in the table, saddle, and column ensure smooth accurate contours without backlash.
- Closed-loop Feedback utilizing TRAK Sensors with .0002" underlying resolution. This is optional for the Sport B3 & B5.
- Modular Design simplifies service and maximizes uptime.
- 115V-60HZ-15 amps.
- Feedrate Override of programmed feedrate and rapid.
- Polycarbonate Sealed Membrane Keypad and Gasket Sealed Control
- Enclosures to lock out contamination.
- 9" CRT for clear presentation of prompts, status information and part graphics.
- Built-in Floppy Disk Storage for program storage.
- RS 232 Port for interface with computers.
- Auxiliary Function to interface with Haas type rotary indexers (DPM)
- Auxiliary Function to control A/C outlet (DPM).
- Auxiliary Function to control Air Solenoid System (spray misters) (DPM).

2.7.2 ProtoTRAK M3 Controls - Sport B3 & B5

- Digital Servo Amplifiers custom designed for ProtoTRAK M3 operation.
- D.C. Servo Motors for the X and Y-axes at 280 in/oz for the B3, and 560 in/oz for the B5. The Z-axis is rated at 560 in/oz for both the B3 and B5.
- Ball screws in the table, saddle and column ensure smooth accurate contours without backlash.
- Closed-loop Feedback utilizing .000036" resolution motor encoders.
- Modular Design simplified service and maximizes uptime. 115V-60HZ-15 amps.
- Feedrate Override of programmed feedrate and rapid.
- Polycarbonate Sealed Membrane Keypad and Gasket Sealed Control
- Enclosures to lock out contamination.
- 9" CRT for clear presentation of prompts, status information and part graphics.
- Built-in Floppy Disk Storage for program storage.
- RS 232 Port for interface with computers.
- Auxiliary Function to interface with Haas type rotary indexers (B3 option only).
- Auxiliary Function to control A/C outlet (B3 option only)
- Auxiliary Function to control Air Solenoid System (spray misters, B3 option only).
- Electronic Handwheels for the X and Y axes (B5 only)

2.7.3 ProtoTRAK SM Control - DPMS3 & DPMS5

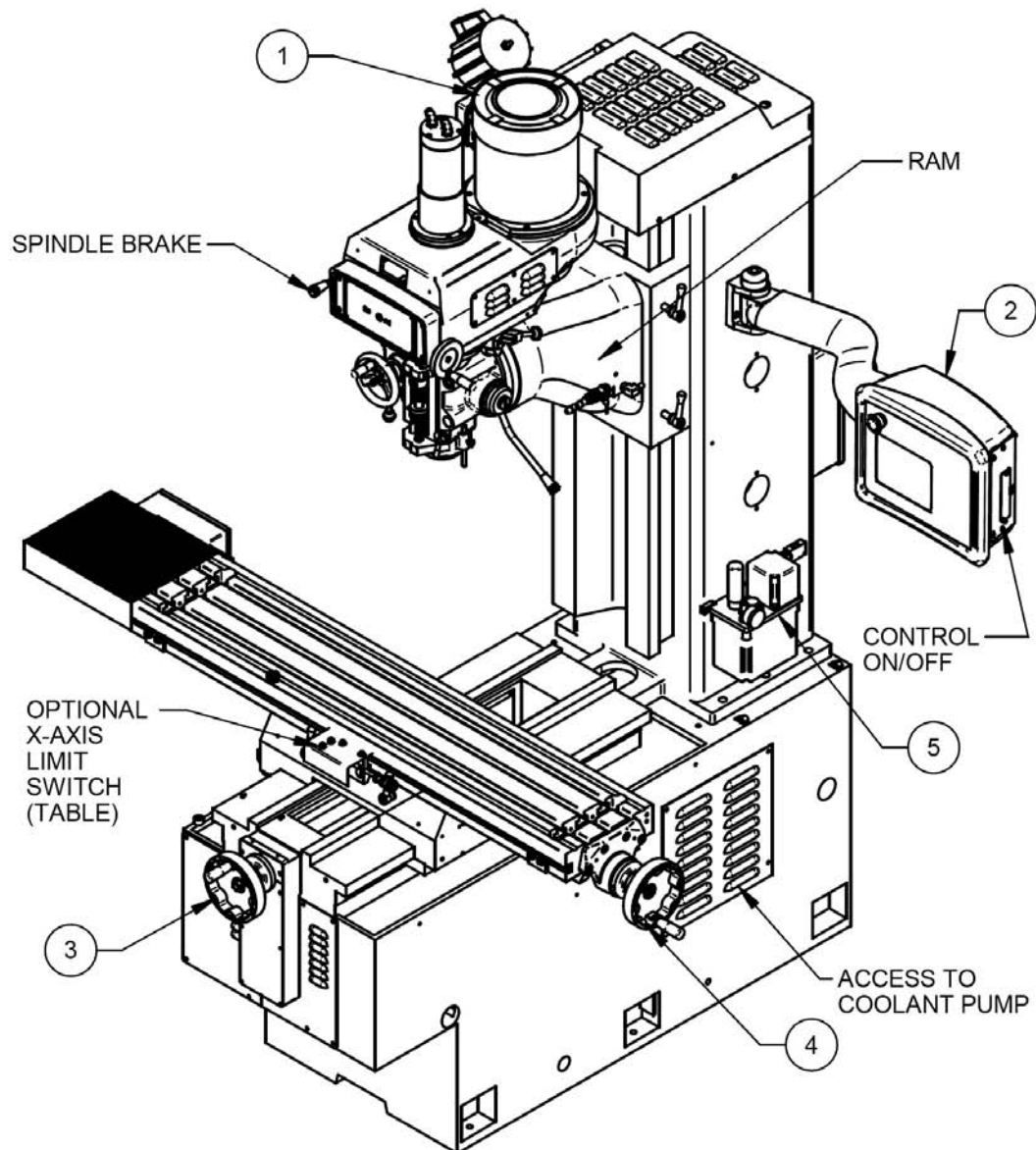
- 3-axis CNC, 3-axis DRO
- 233 PC-based processor

- 32 MB of RAM
- D.C. Servo Motors rated at 560 in-oz continuous torque for X, Y and Z-axes
- Precision ground ball screws in the table, saddle and ram to ensure smooth accurate contours without backlash
- Feedrate override of programmed feedrate and rapid
- Polycarbonate sealed membrane and gasket sealed control enclosure to lock out contamination
- 10 ½" color LCD for clear presentation of prompts, status information and part graphics
- RS232 port for interface to computers
- Modular design simplifies service and maximizes uptime
- 64 GB flash drive
- Optional flash expansion slot
- Single floppy disk drive for additional part program storage
- Optional auxiliary function box for control of coolant pump or spray mist coolant, spindle off and a programmable rotary table or indexer

2.7.4 ProtoTRAK Edge 3 Control – DPME2

- Precision ground ball screws in the table, saddle and ram to ensure smooth accurate contours without backlash
- Feedrate override of programmed feedrate and rapid
- Polycarbonate sealed membrane and gasket sealed control enclosure to lock out contamination
- 7.4" LCD for presentation of prompts and status information
- Modular design simplifies service and maximizes uptime
- Single floppy disk drive for additional part program storage
- 3-Axis CNC, 3-Axis DRO: The Edge 3 CNC works like what is commonly referred to as 2½-axis. 2½-axis means that there is a third axis present (Z-axis), but you cannot program all three axes to move at the same time. In the ProtoTRAK Edge 3 the Z-axis will always move first, and then X and Y. Therefore you cannot program any type of part where you would need to move the Z-axis at the same time as X or Y.
- The D.C. Servo Motors for the X and Y-axis are rated at 280 in-oz. maximum continuous torque. The Z-axis is rated at 560 in-oz. maximum continuous torque.

Figure 2-3 TRAK & Sport Bed Mills Component Identification



I01121

TRAK & Sport Bed Mills Component Identification

Item	Description	Part Number *							
		TRM	DPM	DPM5	Sport B3	Sport B5	DPMS3	DPMS5	DPME2
1	Spindle Motor	16501	16501	20820	16501	20820	20820	20820	23585***
2	Pendant	MX2 15814	MX3 16274	AGE3 20180-1	M3 20347-2	M3 20347-4	SM 22328-3	SM 22328-3	EDGE 23688-USA
		AGE2 20180	AGE3 20180-1		20347-3 (B3 with sensors)				
3	Y-Axis Handwheel	15616	15616	20082-1**	15616	15616	15616	15616	15616
4	X-Axis Handwheel	15616	15616	20082-1**	15616	15616	15616	15616	15616
5	Lube Pump	L001L L001R	21688-4	21157-1	21688-4	21157-1	21157-1	21157-1	21157-2
	X, Y or Z Motor	20276=x 20296=y	20276=x 20296=y 20328=z	21685= x, y 20328=z	20276=x 20296=y 20328=z	21685= x, y 20238=z	23198= x, y, z	23198 = x, y, z	20296= x, y 23198=z

* All replacement part numbers, with exception to lube pumps that are sold as new, have a suffix "R." For example, 23585-1R and 20296R

** 20082-1 = Electric Handwheel

***Programmable spindle motor

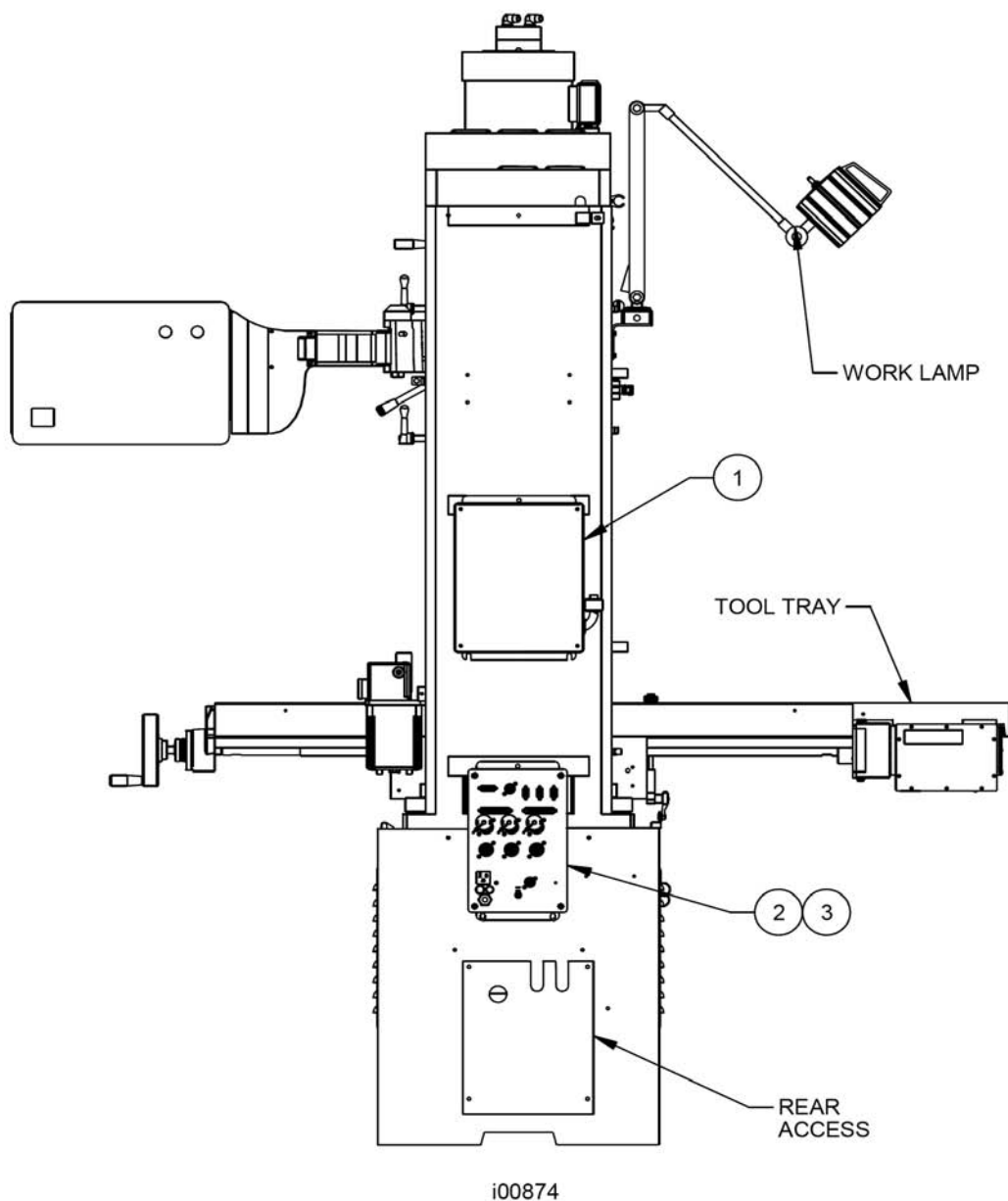


Figure 2-4 TRAK & Sport Bed Mill Rear View

Item	Description	Part Number *					
		TRM	DPM	DPM5	Sport B3 Sport B5	DPMS3/S5	DPM E2
1	Electrical Box/ Relay Module	20065- 220 20065- 440	17009- 220 17009- 440	21800- 220 21800- 440	20676 (220V & 440V) 220V-20676-1 B5 Only	220 = 20676-1 440 = 20676	23630 (220V only)
2	Cable Breakout Box	N/A	N/A	N/A	20290	23050	N/A
3	Cable Breakout Box with AUX Functions	N/A	N/A	N/A	20290-1	23050-1	N/A

* All replacement part numbers have a suffix "R."

For example, 20065-220R and 20676-1R

2.8 Lifting and/or Moving the Machine

CAUTION!

The TRAK & Sport bed milling machines weigh between 3200 and 4400 lbs. Proper equipment of sufficient capacity must be used when lifting and/or moving the machine.

Method 1 (see Figure 2-5):

1. Insert a steel bar 1.0" dia x 36" long through the rear side holes of the bed (under column).
2. Use a steel cable (with protective sleeving) min. 3/4" dia. or a 3 ton sling.
3. Use cardboard pieces or other suitable protective sheets on both sides of the machine to prevent scratching.
4. Remove the 4 nuts and screws holding the machine to the wood skid.
5. Lift the machine (the front side of the machine should be lower than the back side).
6. Insert the 6 screws for leveling pads in their place in the bed. 4 screws for DPME2.
7. Place the machine in its location (see floor plan and bed footprint drawing) carefully positioning each leveling pad under each leveling screw.
8. Remove the lifting cable or sling, the steel bar and all protective cardboard.

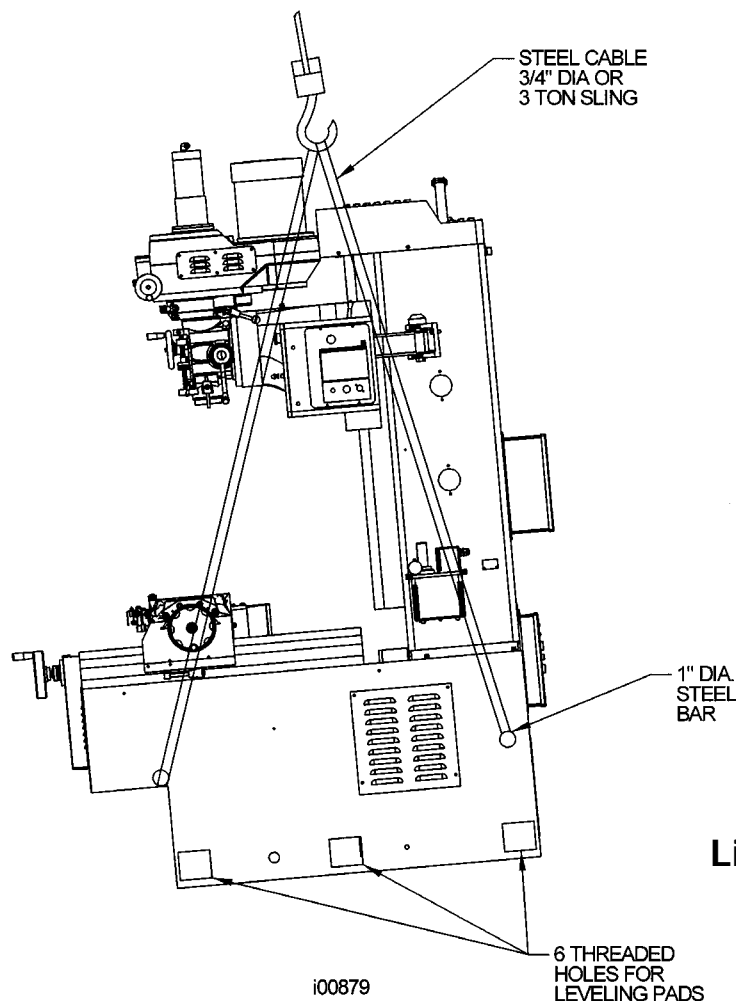


Figure 2-5
Lifting the Machine
Method 1

Method 2 (see Figure 2-6):

1. Insert 2 steel bars 1" dia x 36" long through both sides in the existing holes in the machine base (front and back).
2. Position 4 (two each side) wood vee blocks under the steel bars and over a suitable lift truck.
3. Lift the machine up (somewhat tilted towards the front) 4-6" from the ground and move it to its floor plan position.

WARNING!

The lift truck must have sufficient lifting capacity and be equipped with suitably long forks.

4. Insert the 6 screws for the leveling pads in their place in the bed.
5. Place the machine in its location (see floor plan bed/footprint) carefully positioning each leveling pad under each leveling screw.

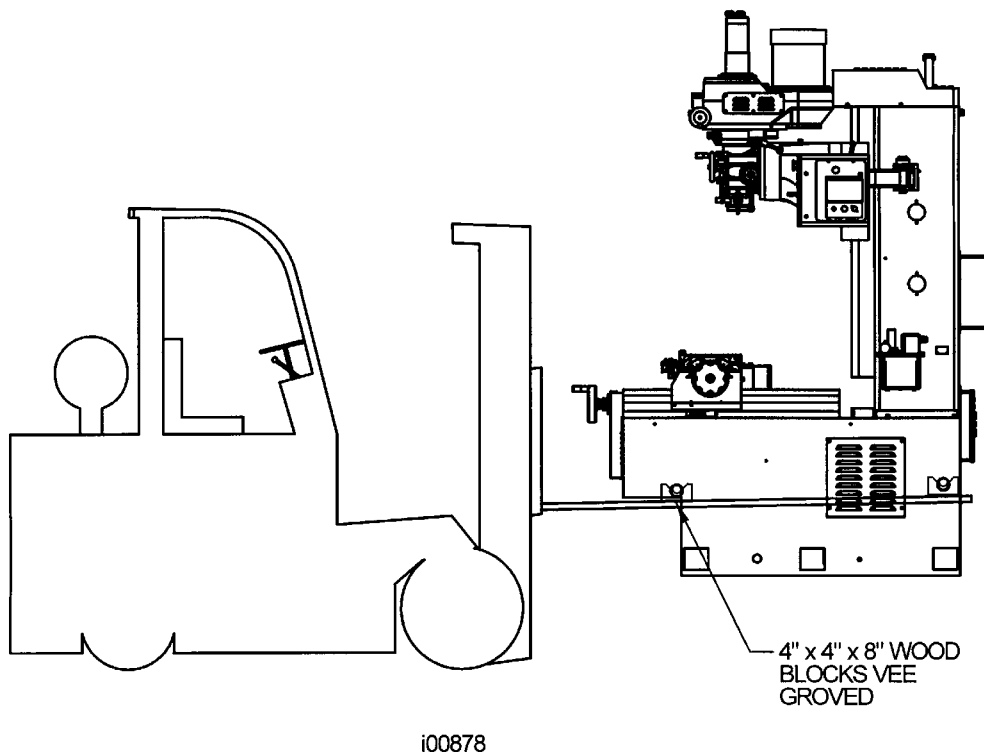


Figure 2-6
Lifting the Machine
Method 2

2.9 Releasing the Head Counterweight Supports

In order to move (raise or lower) the spindle head/ram it is first necessary to remove the 2 steel rods (with flanges) inserted through the holes in the column. These rods support the counterweight during shipping to prevent damage to the counterweight chains and sprockets.

1. Release ram gib locks.
2. DPME2 – Lower the head slowly with a 10mm socket on the top end of the Z-axis ball screw until the chain between the ram and the counterweight is tight.
TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, DPMS5 - Lower the head slowly with the ram crank until the chain between the ram and counterweight is tight.
3. Lower a little further until the 2 support steel rods are loose. Remove the 2 steel rods and store them for future machine moves or transportation.
4. (DPM, DPM5, DPMS3 & DPMS5 only) Remove the panel on the bottom rear of the bed. . Verify that the lower end of the counterbalance rod guide at the bottom of the column is attached using the (2) socket-head cap screws supplied. Replace the panel.
5. Do not continue to move the ram until all ways have been cleaned.

CAUTION!

Do not remove the steel rods unless they are loose.

2.10 Cleaning

1. Remove rust protective coating from the machine before moving any slideways (table, saddle, ram, etc.).
2. The coating is best removed with clean, dry rags. Do not use a cleaning solution that may damage the rubber way scrapers, plastic parts, or paint.

WARNING!

Do not use gasoline or other flammable cleaning agents for cleaning the machine.

3. It may be necessary to move back and forward, left and right, and up and down the table, saddle and the ram. Always release the clamp levers (two in front of the table, one underneath the saddle on each side, and two on the ram on the right side of the column) before attempting to move the above parts.

CAUTION!

Never move any of the above parts over ways that were not previously cleaned. Serious damage to the TURCITE surface of slideways can occur.

4. Be certain the table, saddle, ram, and spindle move freely and smoothly over their entire length.

2.11 Leveling: Leveling Tolerance for TRAK & Sport Bed Mills is .0005"/10"

1. Set the machine on its 6 leveling pads on a solid, level floor prepared in accordance with the state and local rules for machine tool installation. The DPME2 only uses 4 leveling screws.

2. Put one or two precision Spirit Levels or Electronic Levels in the center of the table in the positions illustrated in Figure 2-7.
3. Adjust the 4 corner leveling screws on their pads until the machine is level to .0005 in/10 in. For the TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, and DPMS5, snug the 2 middle leveling screws being careful to not affect the level.
4. If the machine must be anchored to the floor, follow the general instruction for installing machine tools and use for leveling any well-known methods: shims, etc.).
5. If the machine must be installed on vibration mounts/pads (rubber, commercially available leveling and vibration mounts, etc.) follow the instructions delivered with the mounts/pads, ordering them to satisfy the load of the machine and the maximum weight of the workpiece (6,000 lb.).
6. When machine is correctly level, lock the adjusting screws in place with their hex nuts.

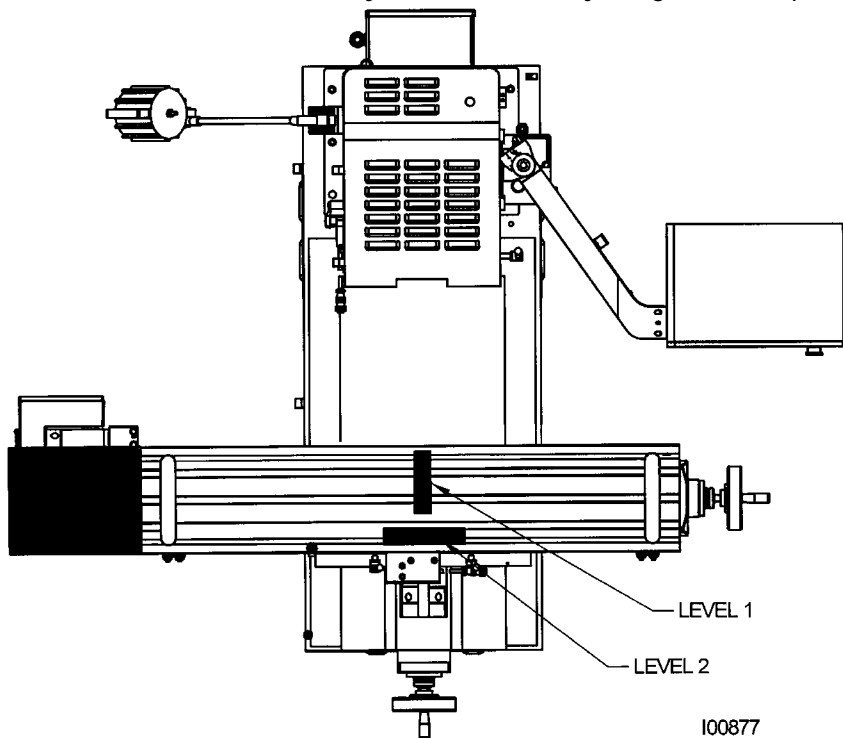


Figure 2-7 Placement of Levels

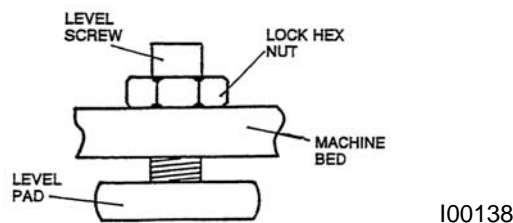


Figure 2-8 Leveling Screws

2.12 Electrical Connection

The TRAK & Sport Bed Mills can be configured for 220 or 440-volt 3-phase electricity with exception to the DPME2, which is only configured for 220 volt electricity. These machines also require a 110V power source to power the control.

DANGER!

Be certain that 200-volt electricity (typical range 208 – 240V) is used only with a machine labeled 220 volts at the motor and at the electric's box on the back of the column.
Be certain that 400-volt electricity (typical range 415 - 460V) is used only with a machine labeled 440 volts at the motor and at the electric's box on the back of the column.

DANGER!

The 220 or 440-volt line must originate from a dedicated and independent fused box with a manual shut-off lever. It is the responsibility of the purchaser to supply a wired box that meets all local codes and regulations.

Incoming 220 or 440 power connects to the machine through the electrical box located on the back of the column. The power cable enters the black box through a hole on the top of the box.

DANGER!

Only a qualified electrician should wire the 220 or 440-volt 3-phase electricity.

To convert a DPMS3 machine from 220 to 440 volt power or vice versa 3 things must happen: spindle motor must be rewired, overload relay must be set to 8.5 amps for 220 V and 4.25 for 440 volts and the voltage stickers on the electric's box must be replaced.

To convert a DPMS5 machine from 220 to 440 volt power 3 things must happen: spindle motor must be rewired, overload relay must be replaced and set to 14 amps for 220 V and 7 for 440 volts and the voltage stickers on the electric's box must be replaced.

See Section 5-30 and 5-31 for diagrams on wiring the spindle motor.

Southwestern Industries recommends the machine be earth grounded by driving a copper rod into the ground. It is the responsibility of the customer to install this rod.

Part number reference table for TRAK & Sport Bed Mill Pendants

Description	Part Number *							
	TRM	DPM	DPM5	Sport B3	Sport B5	DPMS3	DPMS5	DPME2
Pendant P/N	MX2 15814	MX3 16274	AGE3 20180-1	M3 20347-2 (without sensors)	M3 20347-4	SM 22328-3	SM 22328-3	EDGE 23688-USA
	AGE2 20180	AGE3 20180-1		20347-3 (B3 with sensors)				

Part number reference table for wiring the TRAK & Sport Bed Mills

Description	Part Number *					
	TRM	DPM	DPM5	Sport B3	Sport B5, DPMS3/S5	DPME2
Electrical Box/ Relay Module	20065-220 20065-440	17009-220 17009-440	21800-220 21800-440	20676 (220V & 440V)	220 = 20676-1 440 = 20676	23630 (220V only)
Relay - Overload	220V = Z00-10 440V = Z00-6	N/A	N/A	220V=23438-1 440V=23438	220V=23438-1 440V=23438	N/A
Relay Module with transformer option	N/A	20157-220 20157-440	N/A	N/A	N/A	N/A
Contactors (Qty=2) (Reverse or Forward)	DILOOM 94-xxx or older only	N/A				

*** All replacement part numbers, with exception to L001 pumps, have a suffix "R."**

For example, 17009-220R and 23438-1R

2.12.1 Cable Connections for TRM, DPM & DPM5 Pendant

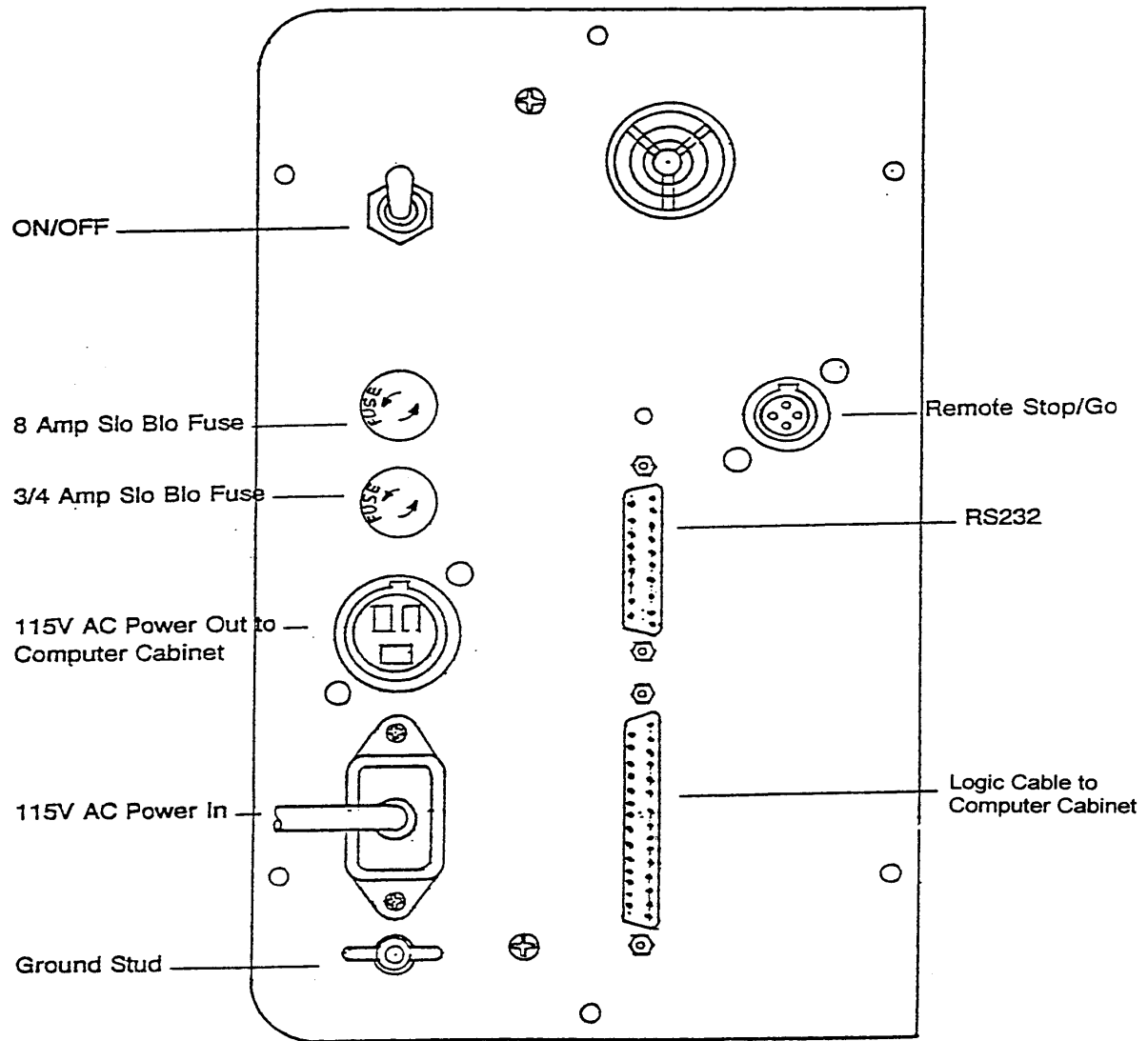
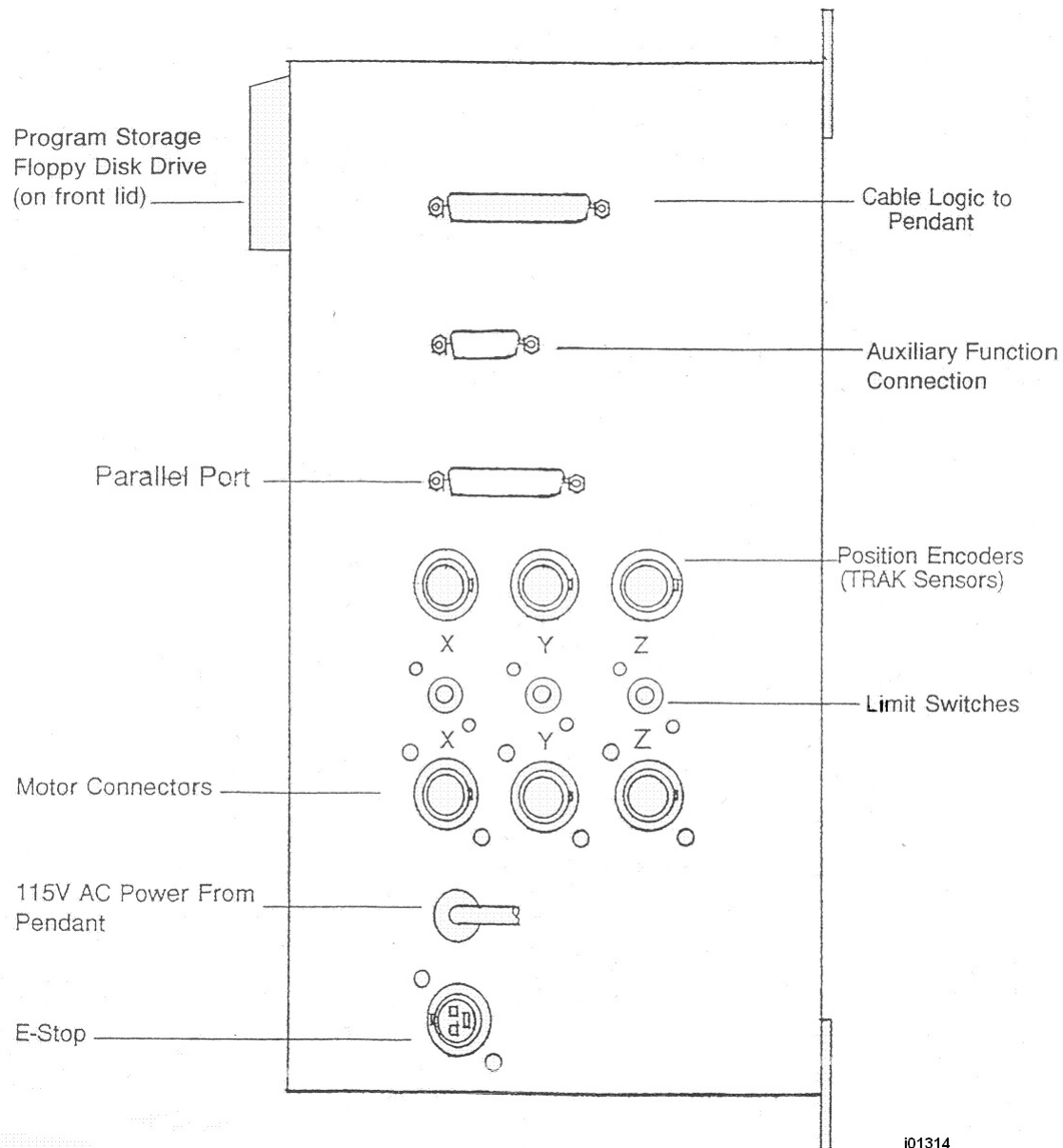
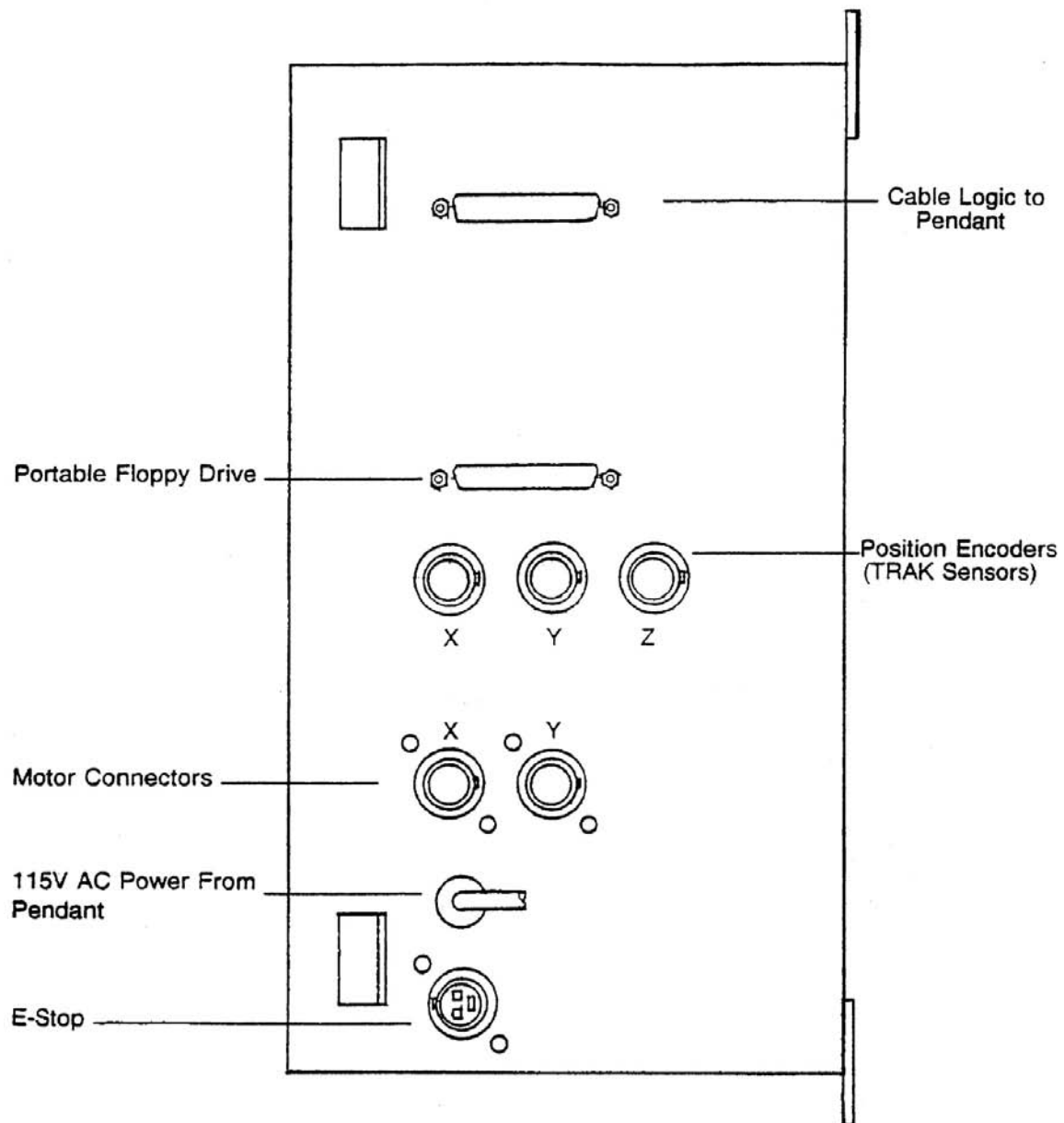


Figure 2-9
Pendant Drawer – AGE 2/3 & MX2/3
TRM, DPM & DPM5



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Figure 2-10
Computer Cabinet – AGE3 & MX3 Connections
DPM & DPM5



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Figure 2-11 AGE2 / MX2 Computer Cabinet – TRM

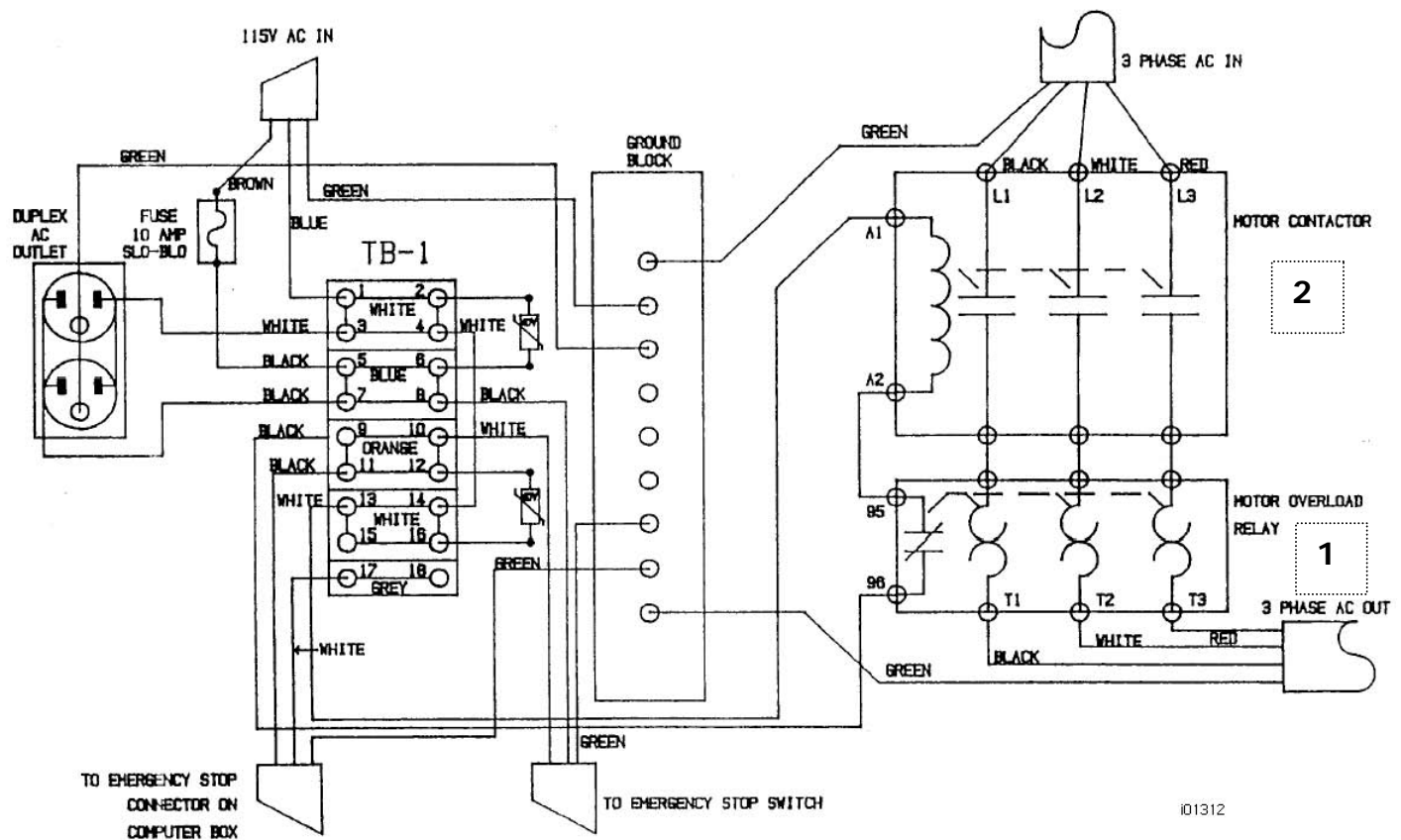


Figure 2-12 TRM Wiring (P/N 16042) for 1995 and earlier

1

Z00-10 = 220V – Motor Overload Relay
Z00-6 = 440 V – Motor Overload Relay

2

DILOOM (220/440) – Motor Contactor

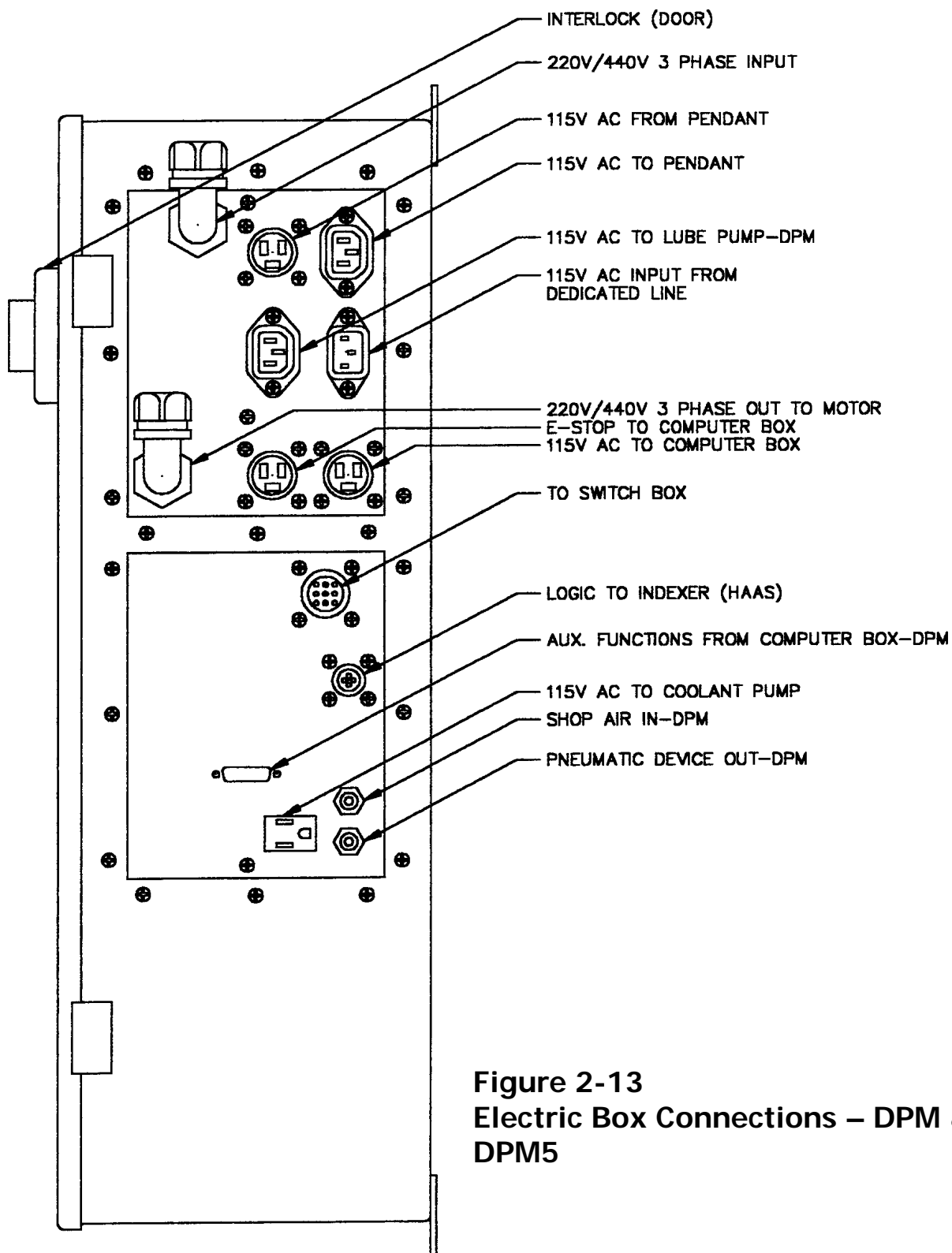
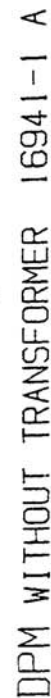


Figure 2-13
Electric Box Connections – DPM & DPM5



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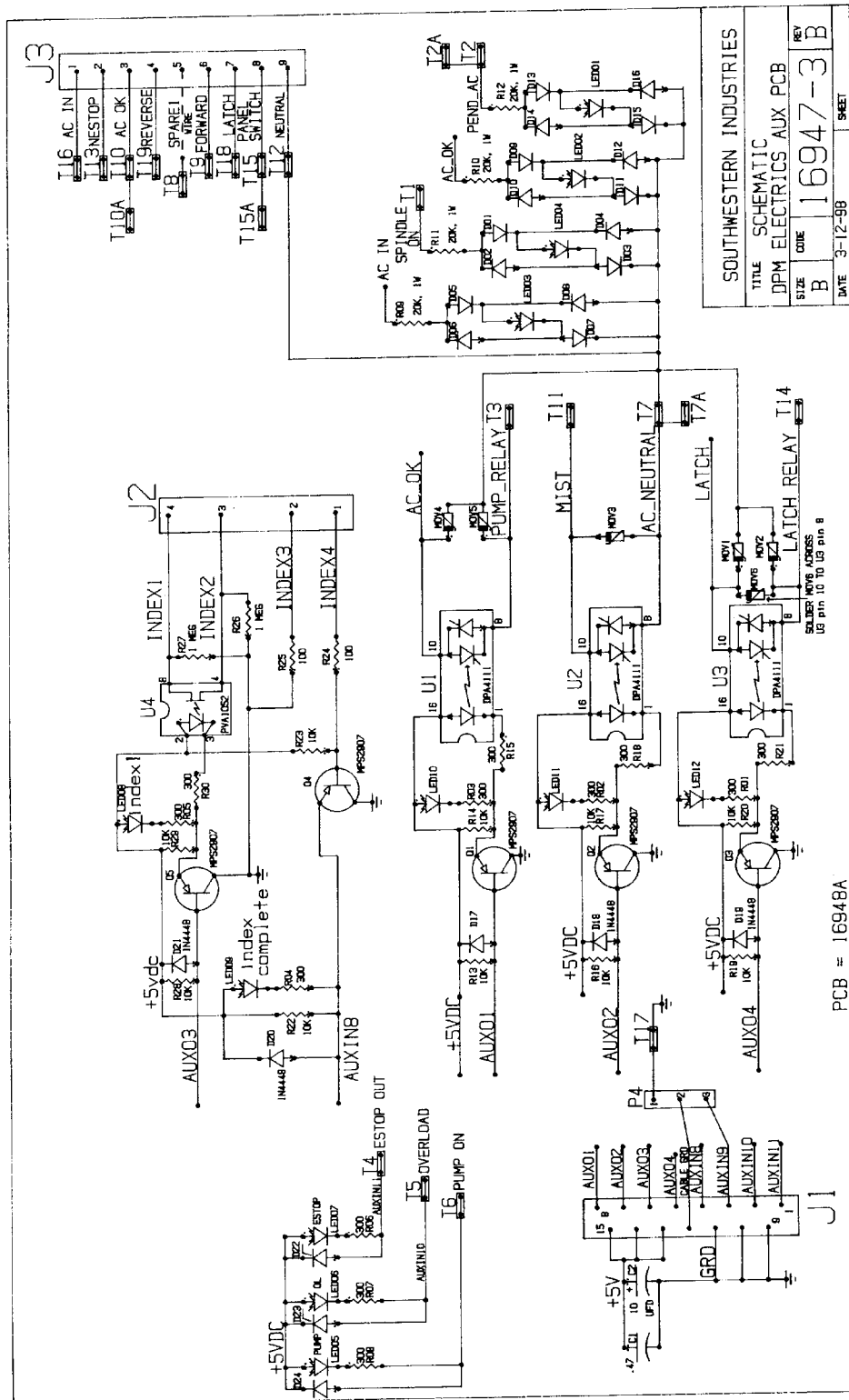


Figure 2-14 Wiring Diagram – DPM & DPM5
(continued from previous page)

2.12.2 Pendant and Wiring Diagrams for Sport B3 & B5 – M3

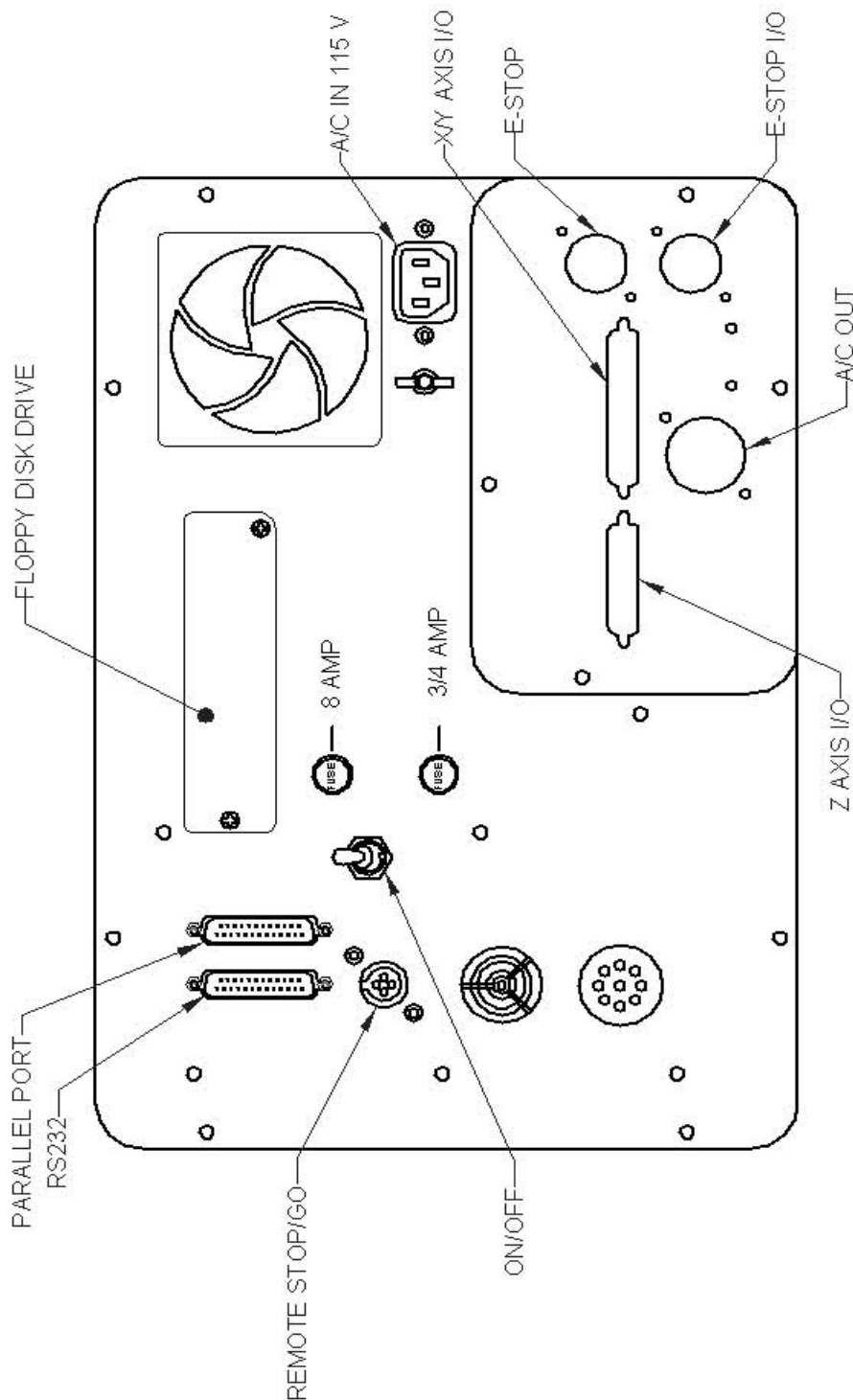
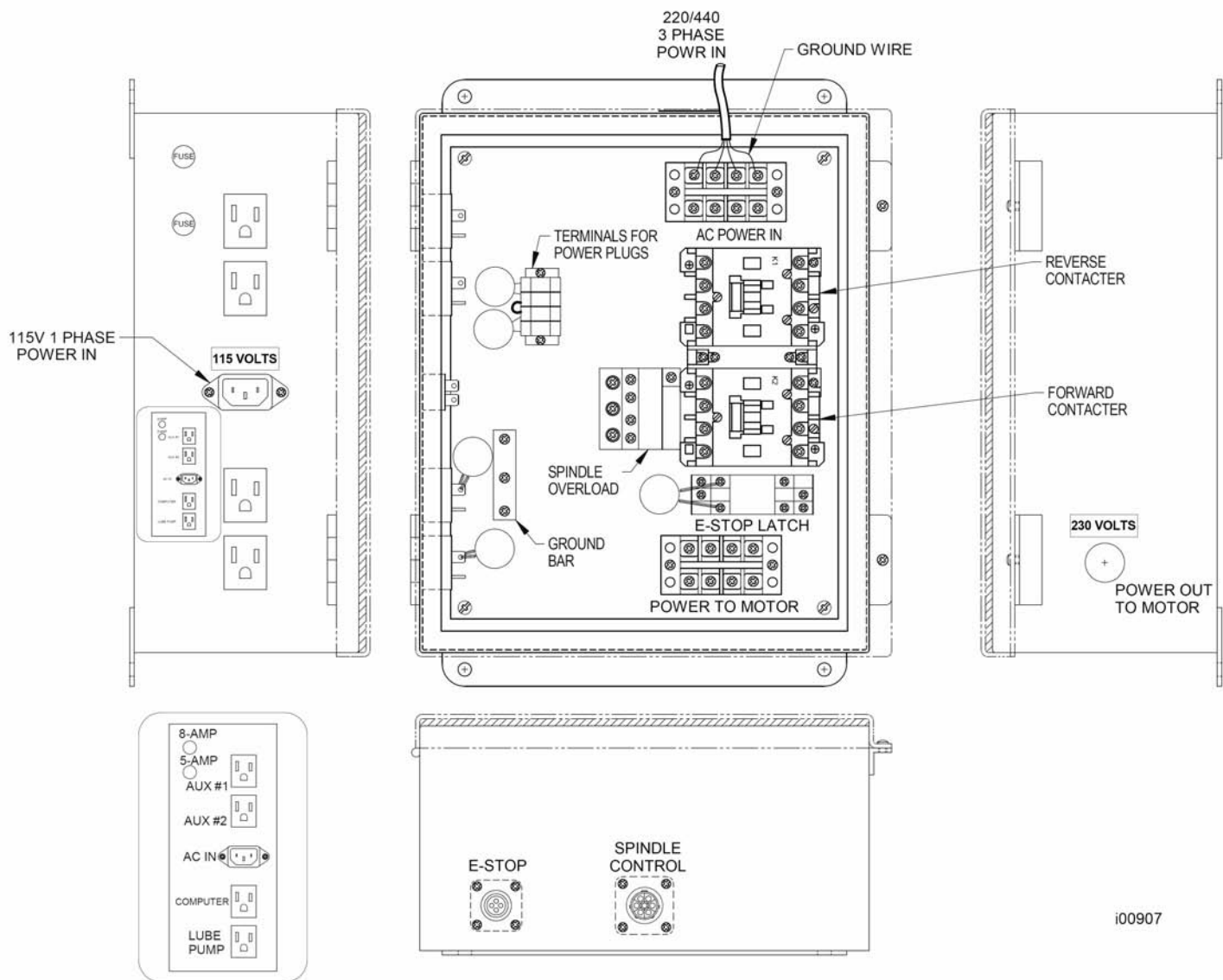


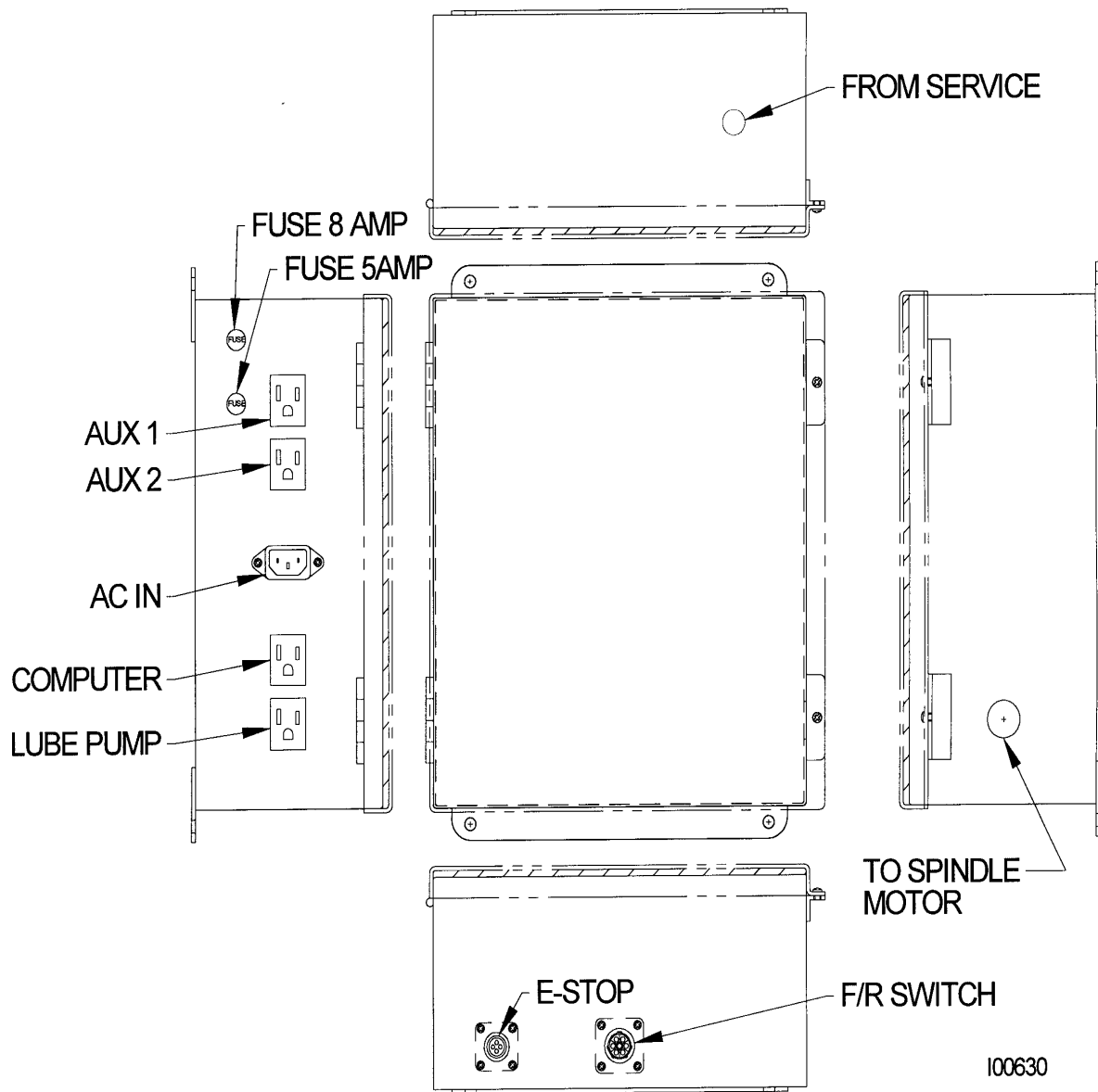
Figure 2-15 M3 Pendant Display Basic Configuration Sport B3 & B5



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Figure 2-16 -- 20676 / 20676-1
Wiring the Sport B3 & Sport B5

Part Number	Description
220V & 440V = 20676	Electrical Box
220V & 440V = 23438-3	Overload
23436	Contactor (Qty = 2) (Reverse or Forward)



**Figure 2-17 – Sport B3 & B5 – 20676 / 20676-1
Electric Box Connections**

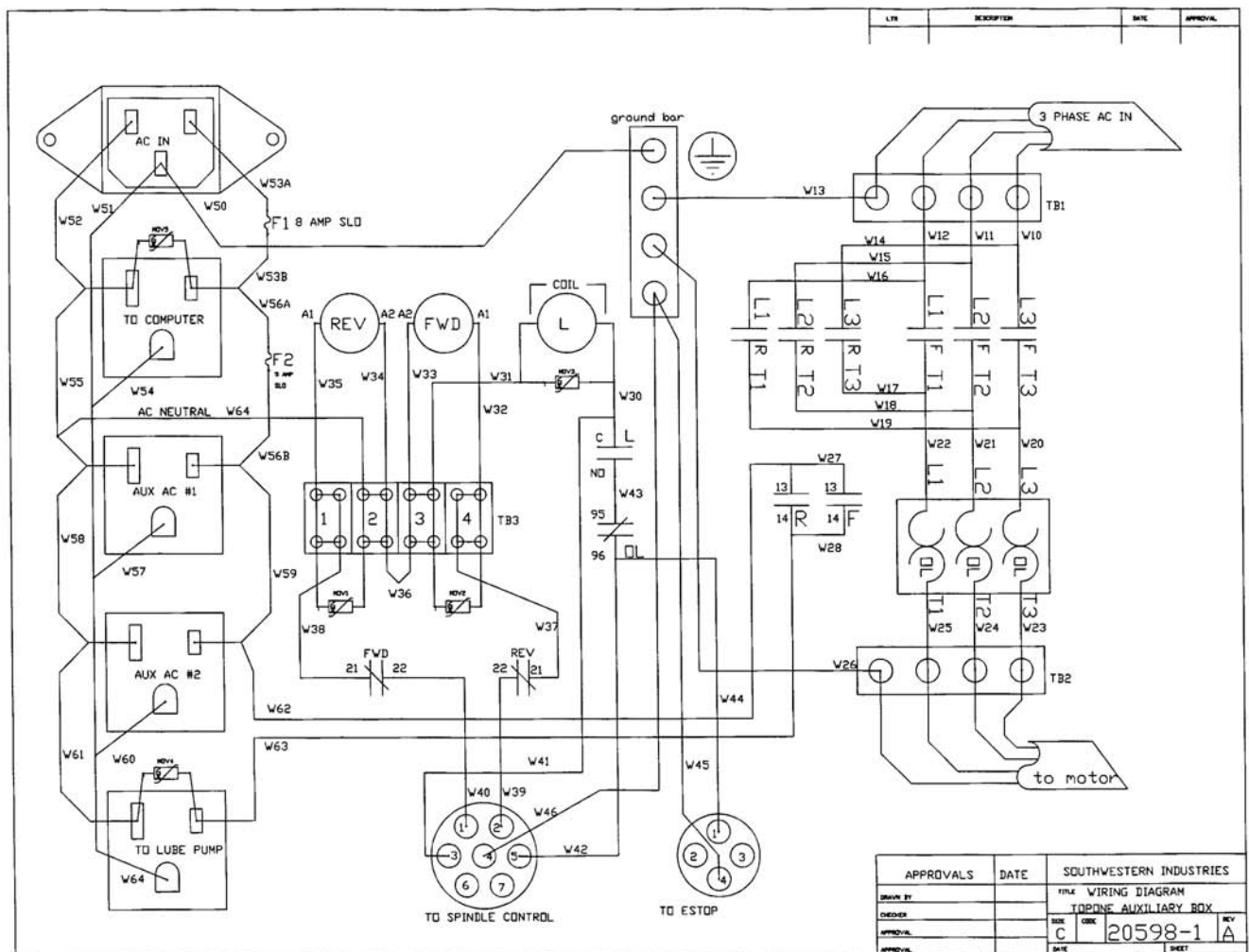
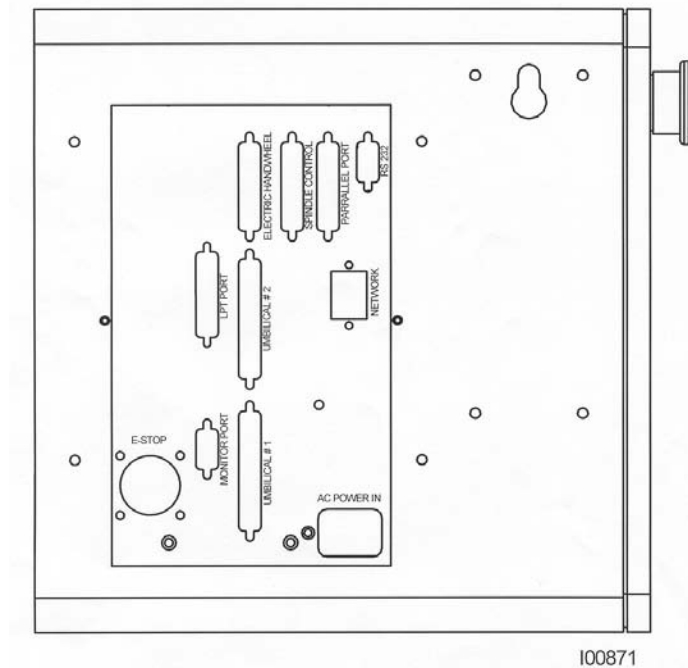
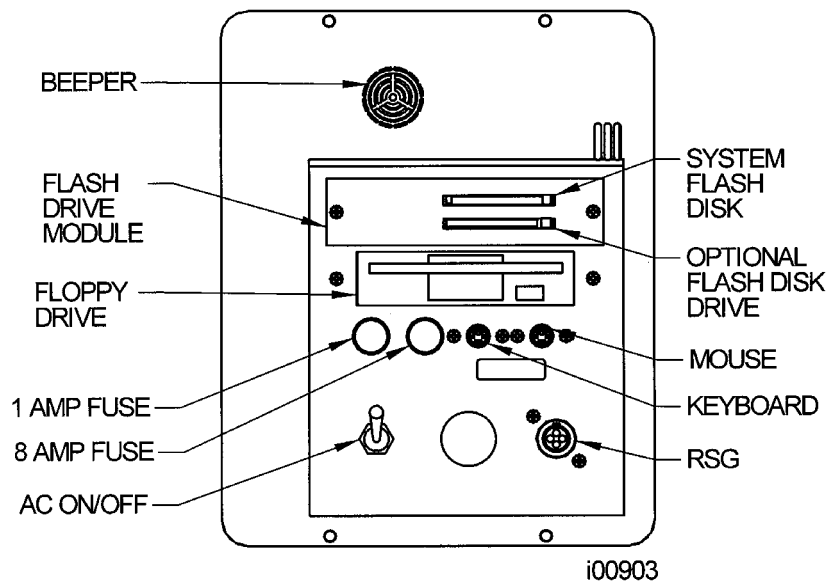


Figure 2-18
Schematic Standard Electric Box – Sport B3 & B5 –
20676 / 20676-1

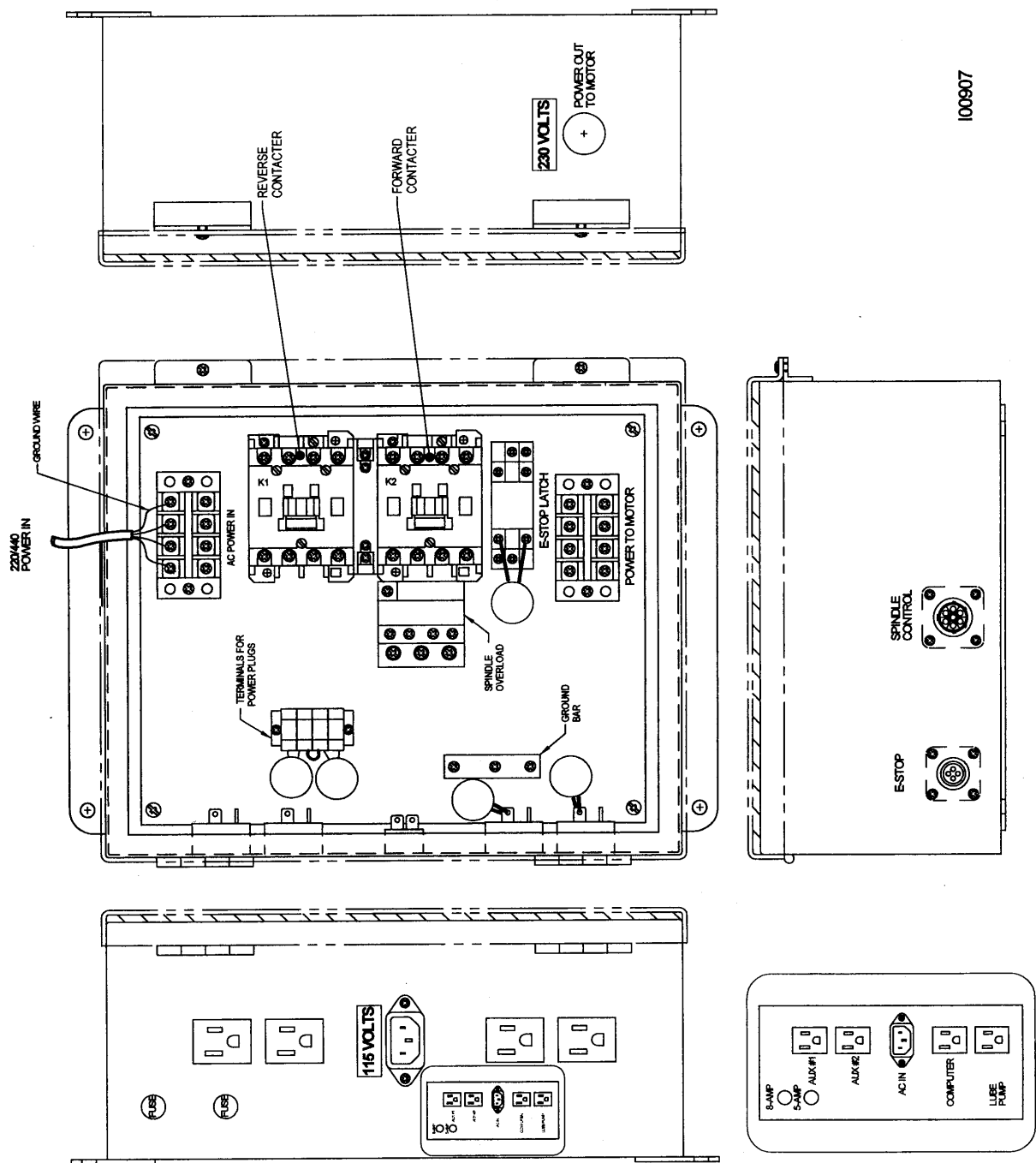
2.12.3 Pendant and Wiring Diagrams for DPMS3 & DPMS5



**Figure 2-19 Pendant Cable Connections – SM
Left Side – DPM S3/S5**



**Figure 2-20 Pendant – SM
Right Side – DPMS3/S5**



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Figure 2-21
Wiring the DPMS3 & DPMS5 – 20676 / 20676-1

2.12.4 Pendant and Wiring Diagrams for DPME2 – EDGE 3

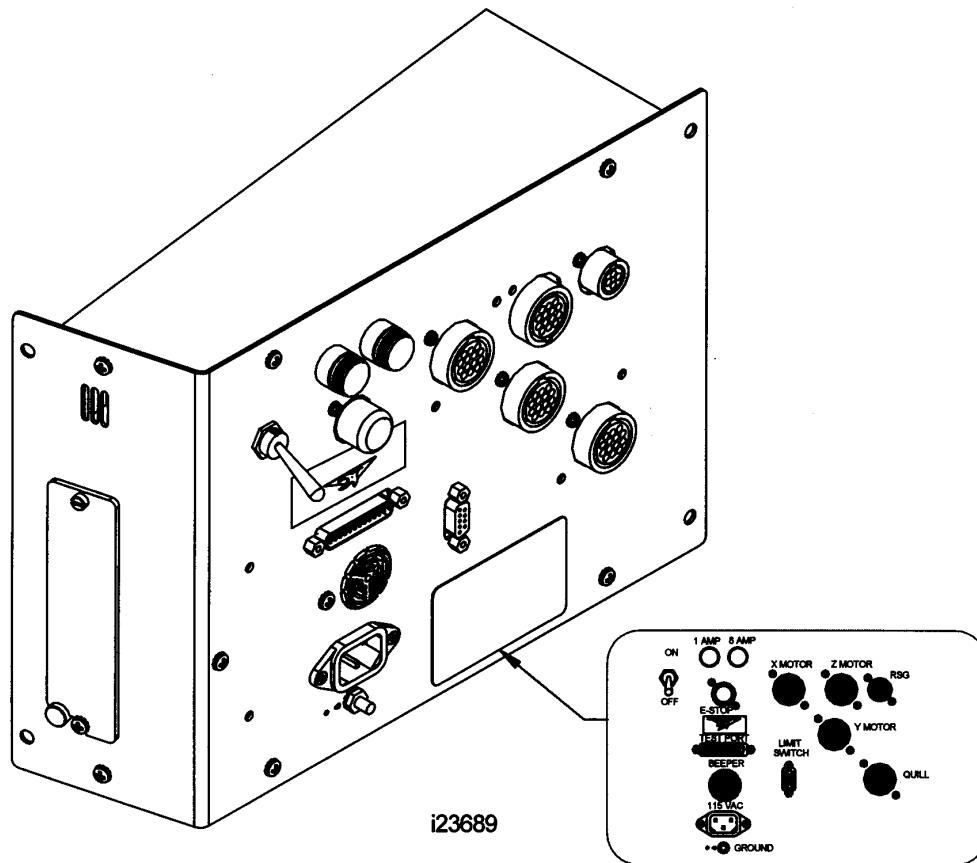


Figure 2-22
EDGE 3 Pendant Rear – DPME2 – 23689 (USA)

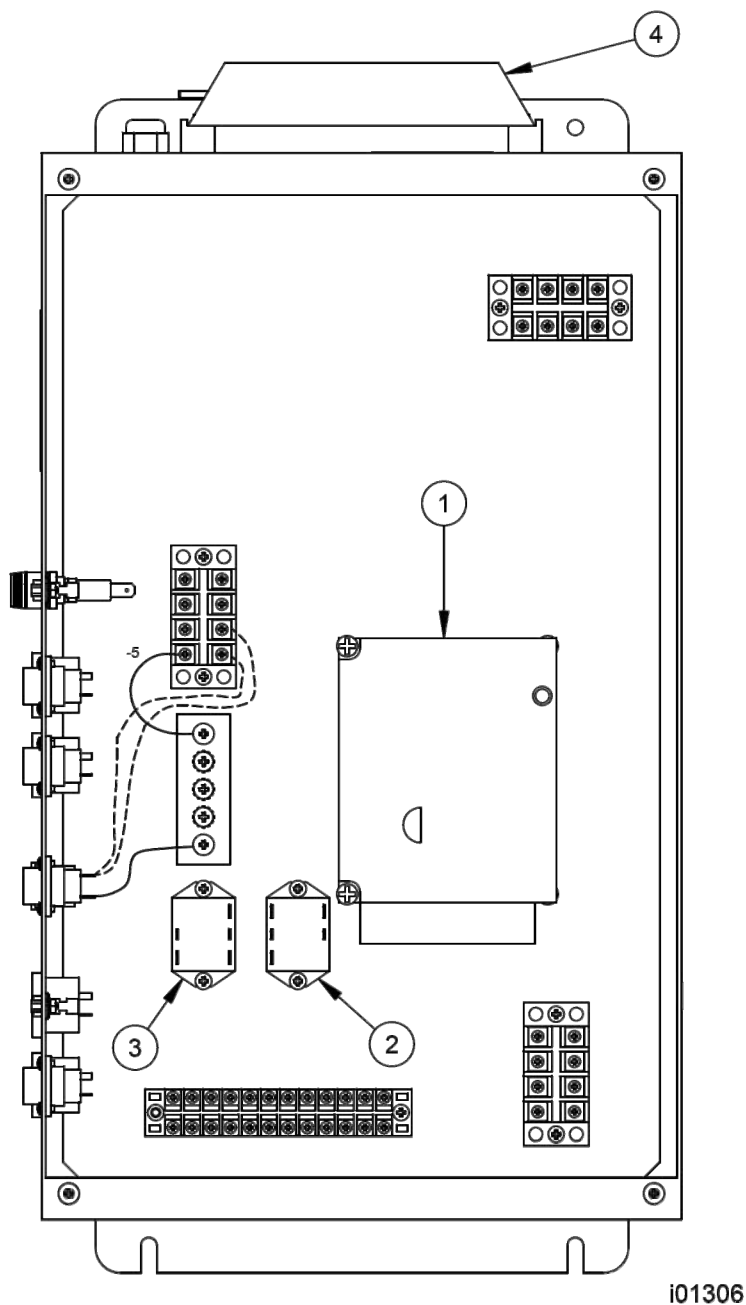
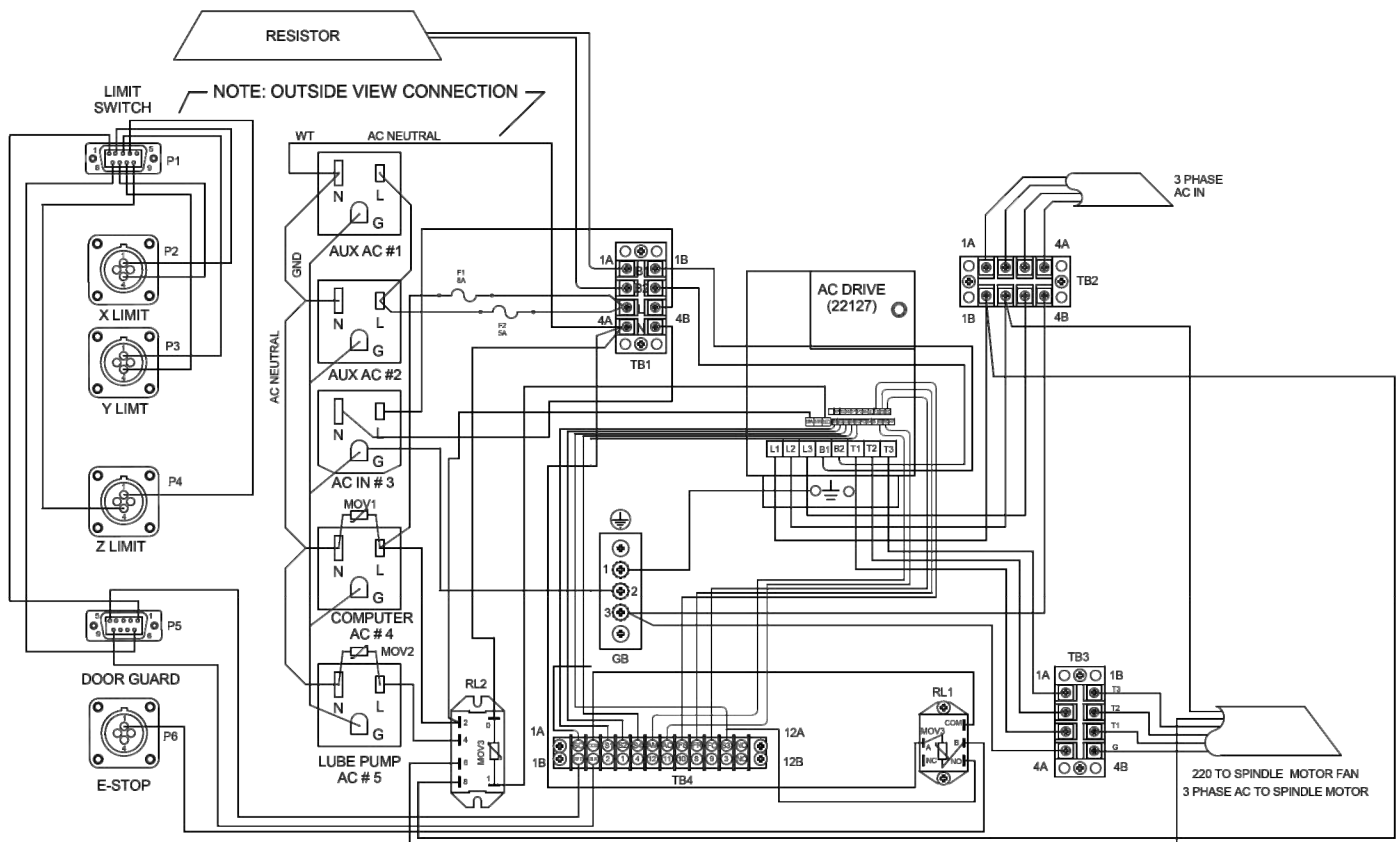


Figure 2-23 Electrical Box Without Transformer – DPME2

Item #	SWI P/N	Description
1	22127-DPME2	AC DRIVE-PROGRAMMED DPME2 3 HP
2	22961	RELAY-POWER-115V DPST
3	22595	RELAY-POWER-115V SPDT
4	22890-200	RESISTOR - 200W - 60Ω

i01306



i01307

Figure 2-24 Electrical Schematic – DPME2

2.12.5 Phase Converters

For those machines that will be run with a phase converter, it is recommended that it is a rotary type rather than a static phase converters. Rotary phase converters allow for varying loads in the system. The electrical load on the machine will vary based on the type of cut taken. Static phase converters can only be used on machines with a non-varying load. The following chart depicts the phase converter ratings per machine model:

Machine Model	Minimum Phase Converter Rating
TRM	5 KVA
DPM	5 KVA
DPM5	7 KVA
Sport B3	5 KVA
Sport B5	7 KVA
DPMS3	5 KVA
DPMS5	7 KVA
DPME2	5 KVA

2.13 Air Connection – Optional for DPME2, DPMS3, & DPMS5

The TRAK & Sport Bed milling machines have an air hookup in the rear of the machine if the machine has a power drawbar or auxiliary function option.

The drawbar option includes an air regulator, air manifold and an oiler. The auxiliary option includes an air regulator, air manifold and a solenoid. If both options are included on the same machine, a regulator, manifold, oiler and solenoid will be included. The air fitting is ¼" NPT. An additional air line port is on the manifold to be used for an optional mister. Remove the plug to gain access to this port.

The air regulator is set to 90 PSI at the factory for the power drawbar unit and solenoid. See Section 5.1.8 for more information on the power drawbar unit. The air comes in through the manifold and passes through the air regulator. The regulator branches into two components--an oiler for the power drawbar unit and an air solenoid. The solenoid is used for a misting system that the user may install later on this machine. The mister air hose can be plugged into the ¼" quick disconnect air fitting on the solenoid.

2.14 Mounting the Display Pendant

The display pendants for the ProtoTRAK M3, SM & MX and the TRAK AGE mount to the pendant arm with four 1/4-20 x ¾ SHCS that are shipped screwed into the left side of the display. The ProtoTRAK Edge 3 display pendant mounts the same way except with 3 studs. The Edge 3 requires (3) 3/8-16 nuts and washers to fasten the pendant to the arm. For all models, a locating screw on the pendant arm helps align the pendant with the mounting holes.

CAUTION!

The locating screw in the arm is used for positioning. Hold the pendant firmly until the screws are fastened.

If the pendant arm rotates too freely, remove the painted cap on the bracket attached to the column and tighten the hex nut to adjust it. Replace the cap.

2.15 Cable Interconnections

All cable interconnections are made at the factory except for those connecting to the pendant display.

With the main power to the machine turned off, plug in the connectors that are bundled on the pendant arm. Each cable mates to only one connector on the pendant display back panel. Use the label on the pendant to match the connectors with the correct port.

Ensure that there is sufficient slack in the cables for the pendant to rotate about the pendant arm. The worst case is when the pendant is all the way forward toward the operator. The following drawing describes all of the cable connections to the pendant.

For DPMS3/S5 only: Ensure that an option key is plugged into the option key port of the pendant. This key activates any converters or options ordered. The part # for this key is 22648-5. The key must be programmed according to the type of machine it is on and the options ordered.

The Machine ID port must have a key, or the machine may not run.

CAUTION!

Ensure that the main power is turned off on the back of the electrical cabinet before plugging in the cables.

Part Number Reference Table for TRAK & SPORT Cable Connections

Description	Part Number *							
	TRM	DPM	DPM5	Sport B3	Sport B5	DPMS3	DPMS5	DPME2
Electrical Box/ Relay Module	20065-220/440	17009-220/440	21800-220/440	20676	20676-1 = 220 20676 = 440			23630 220V
Cable Assembly	N/A	N/A	N/A	N/A	N/A	21856 23050	21856 23050	21856
Cable Breakout Box (-1 with AuX)	N/A	N/A	N/A	N/A	N/A	23050-1	23050-1	N/A
Option Key	N/A	N/A	N/A	N/A	N/A	22648-5	22648-5	N/A
Machine ID Key	N/A	N/A	N/A	N/A	N/A	22758-SDPM3	22758-SDPM5	N/A
Pendant P/N (with control model)	MX2 15814	MX3 16274	AGE3 20180-1	M3 20347-2 (without sensors)	M3 20347-4	SM 22328-3	SM 22328-3	EDGE 23688-USA
	AGE2 20180	AGE3 20180-1		20347-3 (B3 with sensors)				

*** All replacement part numbers have a suffix "R."**

For example, 20065-220R, 20065-440R and 22758-SDPM3R

See Figures 2-25 – 2-30 for cable diagrams for each machine model

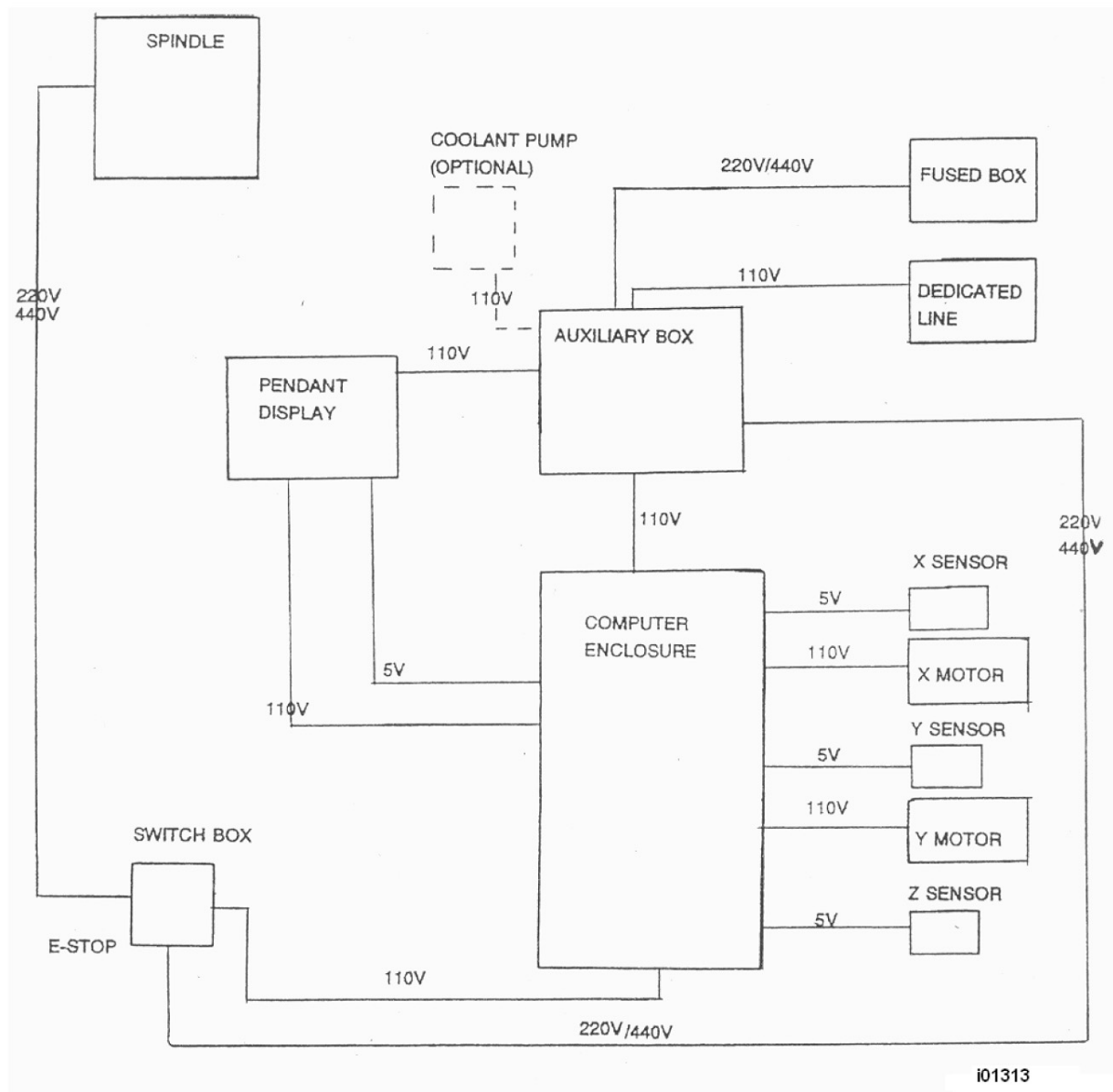


Figure 2-25 Cable Interconnections – TRM / MX2 – 95-xxx and earlier

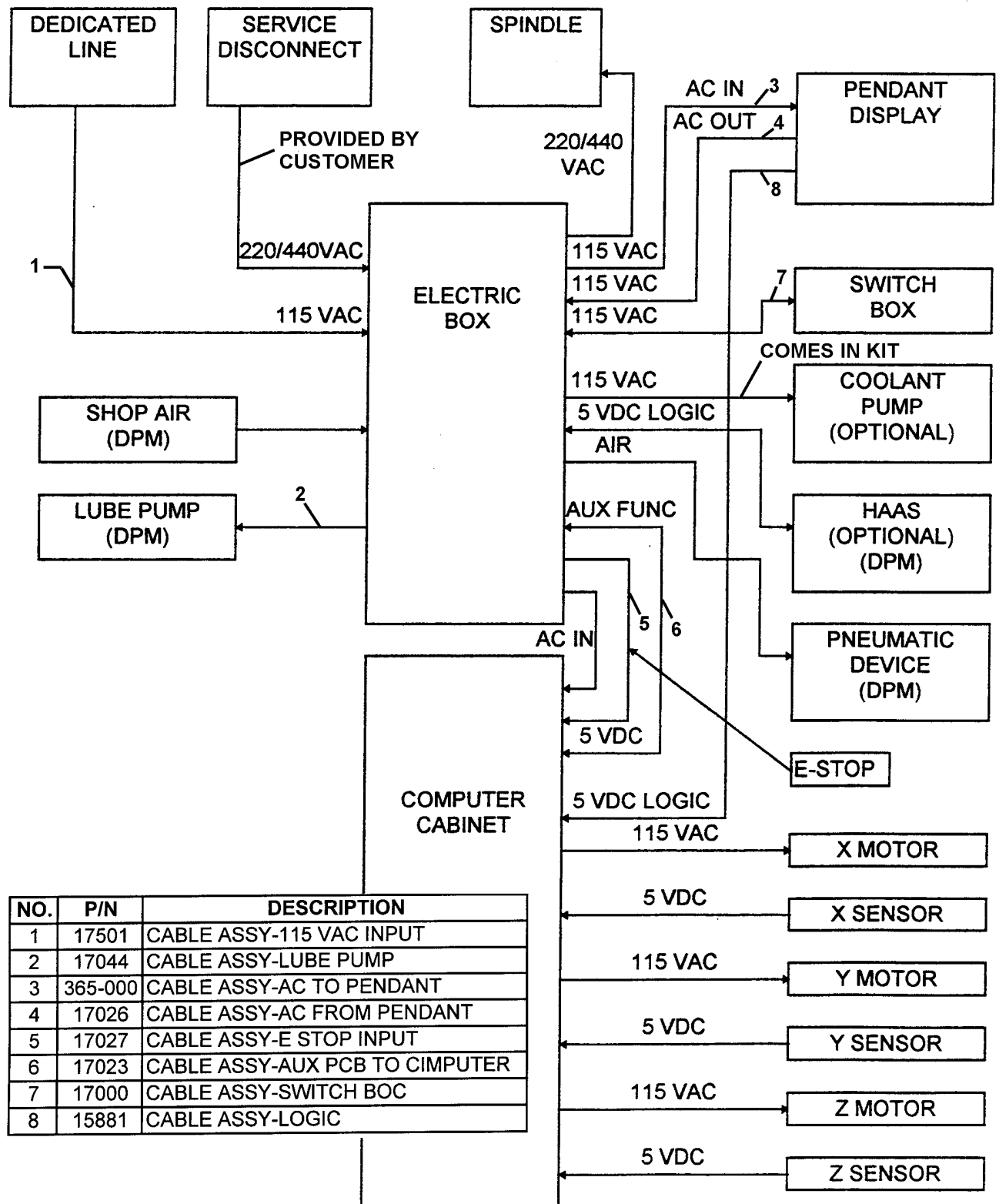


Figure 2-26 Cable Interconnection – DPM & DPM5

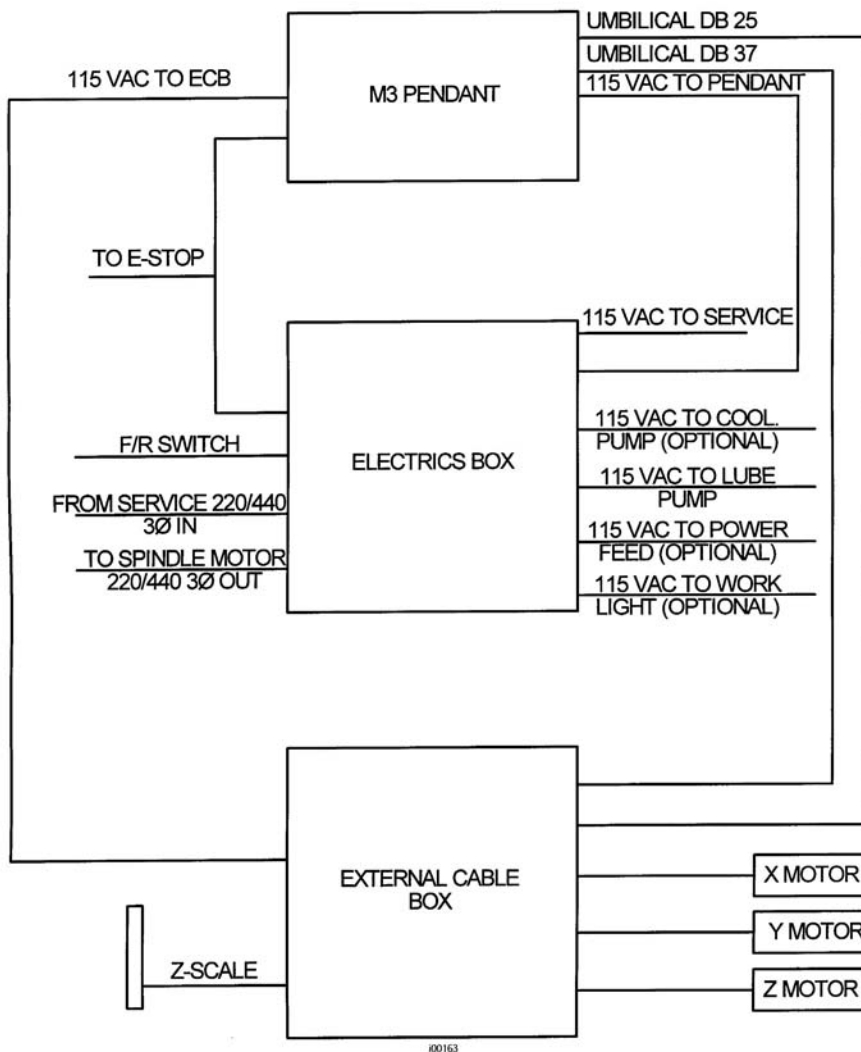


Figure 2-27
Cable Interconnections – Sport B3

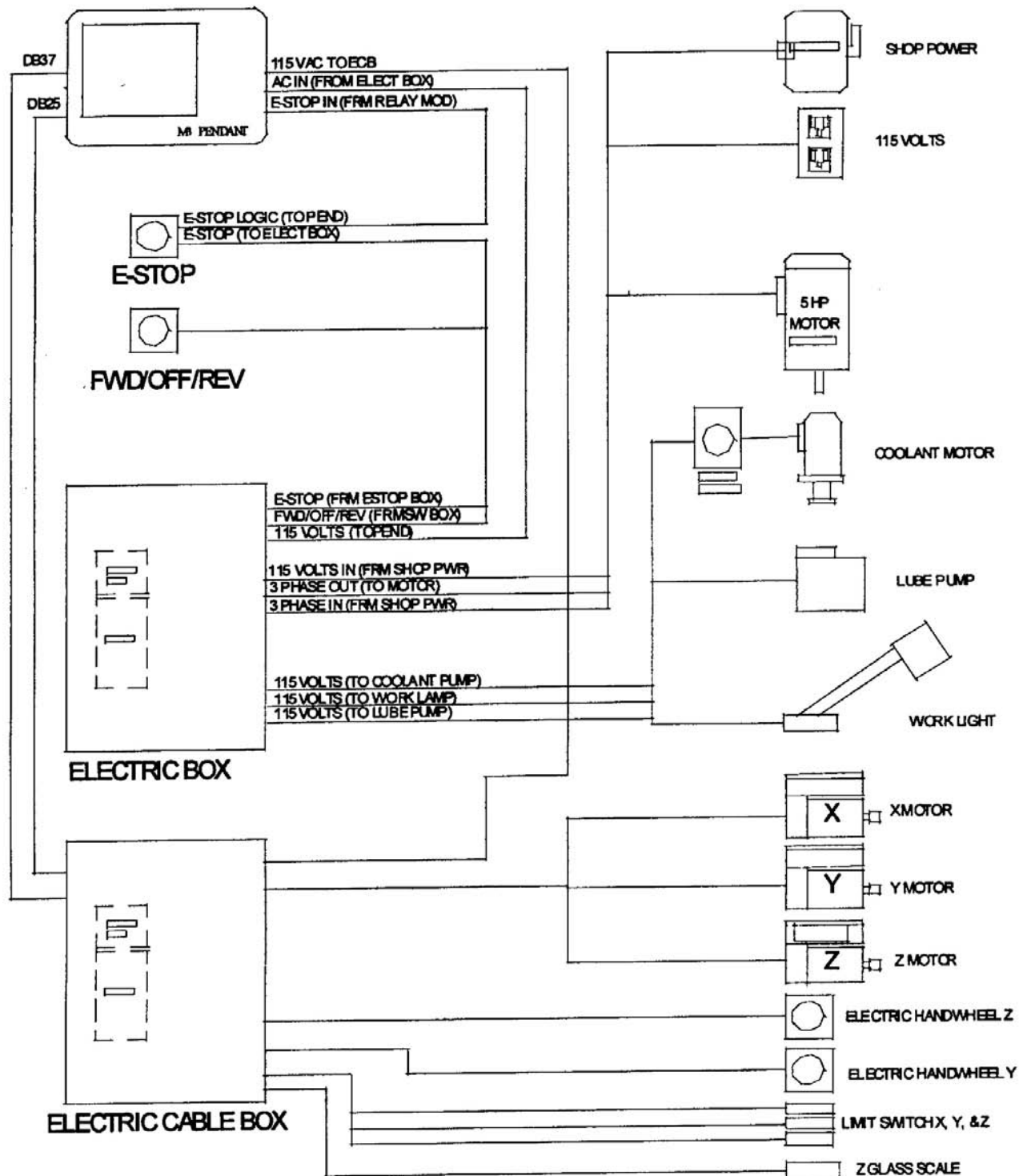


Figure 2-28 Cable Interconnections – Sport B5

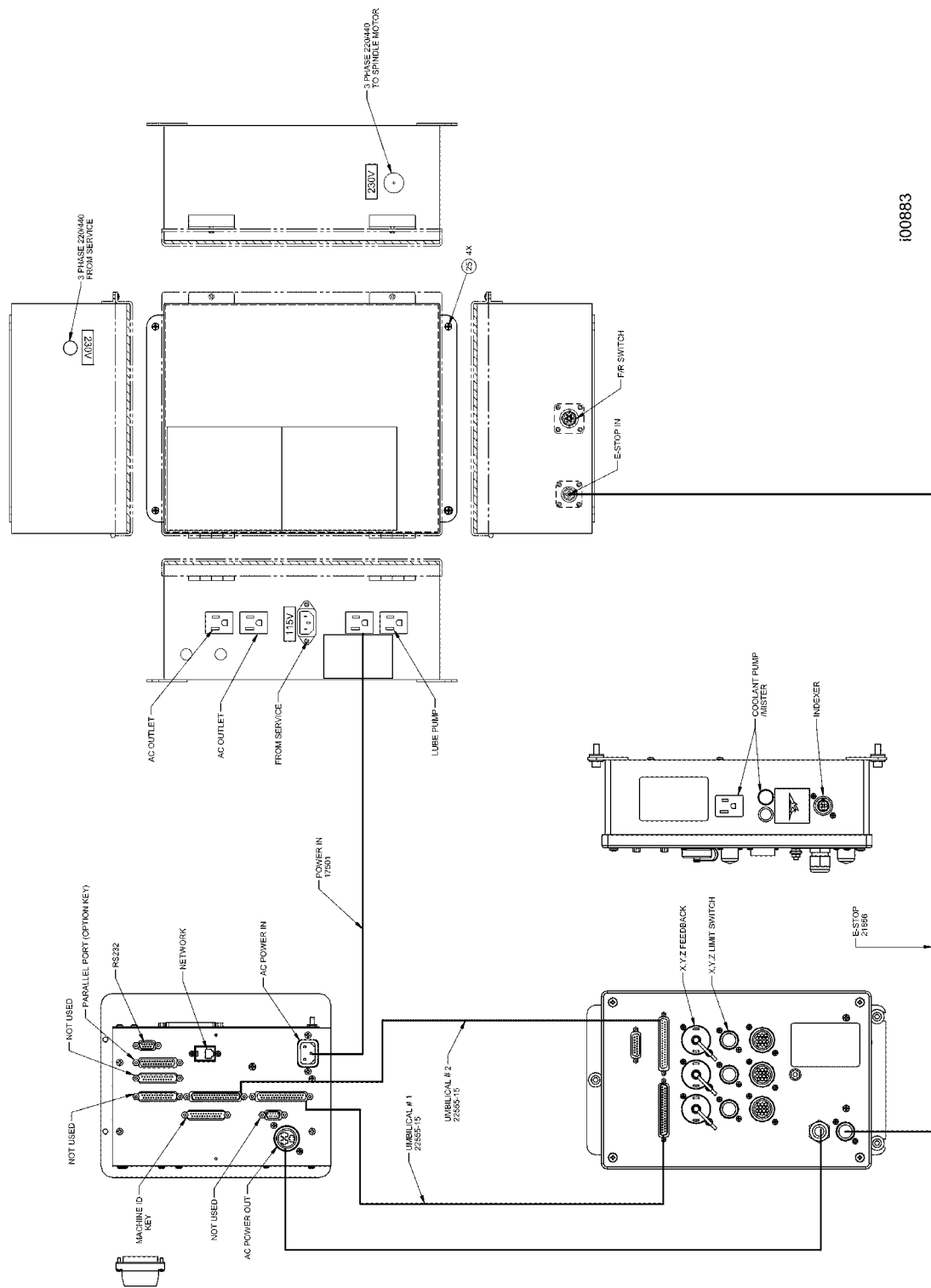


Figure 2-29 Cable Connection Diagram – DPMS3/S5

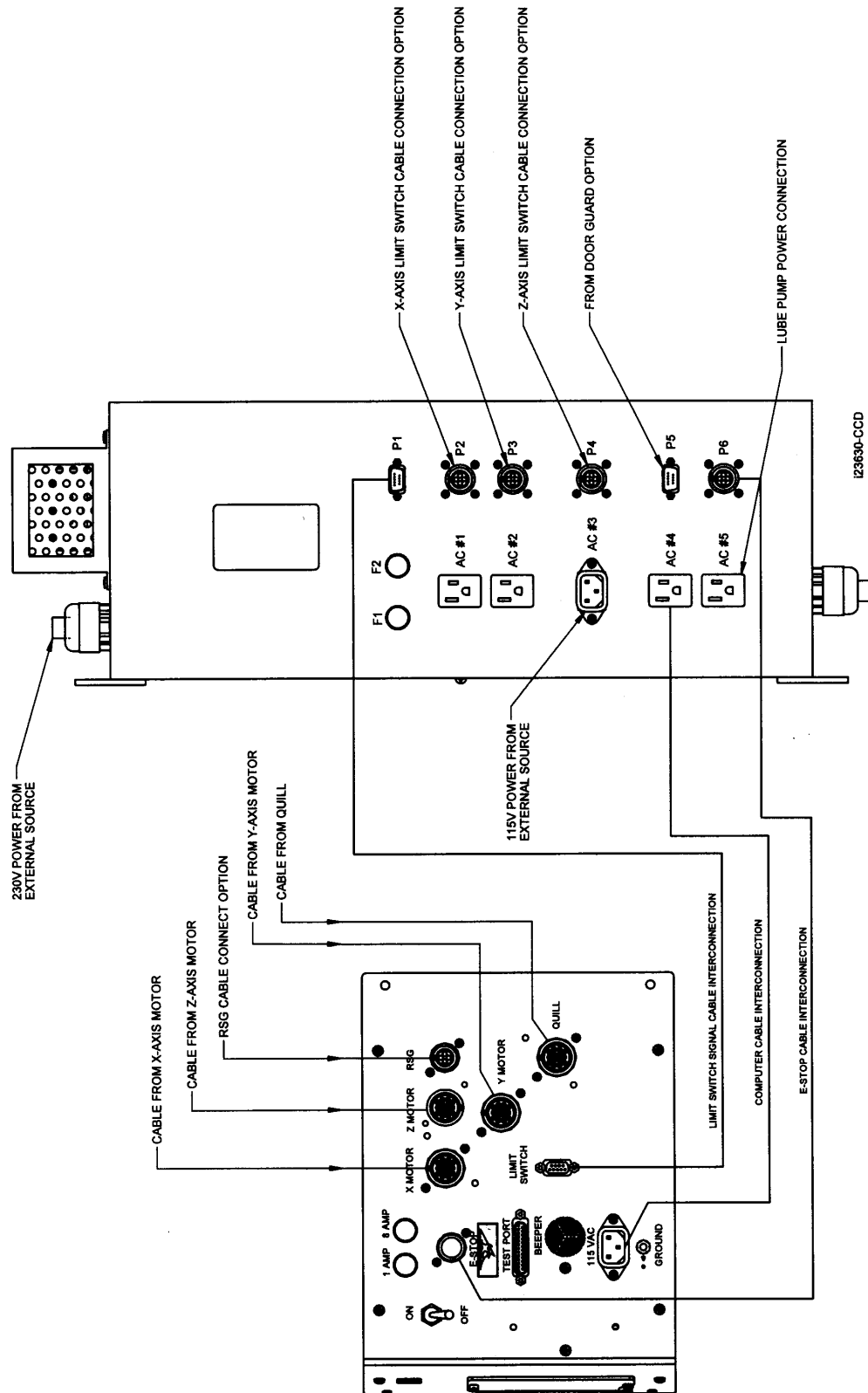


Figure 2-30 Cable Connection Diagram – DPME2

2.16 Lubrication

2.16.1 Way Lubrication

2.16.1.1.1 DPM, DPM5, Sport B5, DPMS3, DPMS5 & DPME2

The auto lube system provides centralized automatic lubrication for the ways and ballscrews. The lube pumps 2-liter reservoir is serviced with Mobil Vactra Oil No. 2 or equivalent. The pump is factory set to pump oil for 15 seconds for every 60 minutes of spindle time. There is an internal memory on the pump so that the pump will not reset every time the spindle is turned off.

The pumping output can be regulated electronically to control the pause time between pumping cycles, and the duration of the pumping cycle. The following describes the buttons used to program the lube pump. In order to modify any of the settings the spindle must be on.

The pump has an alarm that will sound if any of the following problems arise:

- Oil line breakage
- Oil filter blockage
- Bad motor
- Low oil pressure
- No oil in tank

INT (Interval) - this button programs the interval between pumping cycles. Each press of the button increases the interval by one minute.

DIS (Discharge) - this button programs the amount of time the pump will discharge each pumping cycle. Each press of the button increases the discharge time by one minute.

FEED - this button is used to manually feed the ways and ballscrews.

RST - this button tells the pump to discharge for the time programmed.

Factory Default Values

Interval Time - 60 min.

Discharge Time - 15 sec

Discharge Pressure - Approximately 100 - 150psi

To adjust the amount of Discharge Pressure displayed on the lube pump gauge, loosen the jam nut and turn the adjustment screw located on the top right side of the lube pump while the lube pump is activated.

At the beginning of each day, check the oil level in the Auto Lube system. If low, fill with Mobil Vactra Oil No. 2 or equivalent.

CAUTION!

Failure to manually activate the pump at the beginning of each day, or allowing the Auto Lube to run dry may cause severe damage to the TRAK & Sport Bed Mills way surfaces and ball screws.

2.16.1.2 Manual Lubrication - TRM

The TRAK TRM X, Y, Z way surfaces and ball screws are lubricated manually with the lubrication pumps located on the right side of the bed and the left side of the ram. Pull

each handle fully and release 4 to 6 times at the beginning of each shift, and once every four hours of operation thereafter.

At the beginning of each day, check the oil level in each pump. If low, fill with SAE 30 or 30W oil or Mobil Vectra #2.

Every six months of operation, remove the vertical column way covers and apply a liberal coating of Mobile Grease-MP, or equivalent, to the ACME screw.

2.16.2 Head Lubrication – ALL TRAK & Sport Bed Mills

Once Each Week:

1. Fill the oil cup on the front of the head with SAE 30 or 30 W oil. This oil lubricates the Hi/Lo range shifter.
2. Fill the ball oiler located in the front lower right corner of the speed changer housing. This oil lubricates the speed changer shaft.
3. Extend the quill fully and apply a coating of SAE 30 or 30W oil to the outside diameter of the quill.

Every Four Months:

Apply a good grade of general-purpose grease through the grease fittings on the back of the head and on the left side of the head. This grease lubricates the Low range gear set and the feed change gears respectively. Also lubricate vari-disk on spindle motor by means of grease fitting on motor shaft.

Every Four Months (DPMS5 X Handwheel Drive Mechanism):

Remove X handwheel drive cover and apply a general-purpose grease to the drive gears. See Section 5, Figure 5-17 for an illustration

Every Six Months (DPMS3):

Remove lower cover under spindle motor and apply general-purpose grease to the fitting on the spindle motor shaft. You must set the RPM range on the head such that grease enters the vari-disk cavity. Apply two pumps of grease to adequately grease the vari-disks. In high gear set the RPM to between 975 and 1440 RPM. In low gear set the RPM to between 115 and 165 RPM.

Note: Due to the design of the vari-disk keyway, the motor shaft on the DPMS5 does not need to be greased.

2.17 ProtoTRAK Euclid Block Procedure- TRAK & Sport Bed Mills

The test part should be machined at the completion of the installation.

The material for the Euclid block test part is found in the toolbox.

- Material Specification: Aluminum, 6061-T6 or T4
 - Blank Size: (minimum dimensions) 3 x 3 x 1", provided in tool box
 - Tool: .750 end mill, 2 flute, high speed steel, **sharp**
 - Coolant: Flood coolant, Cool-Tool or Kerosene
1. Mount vise and indicate the back jaw parallel to the table within .0005".
 2. Clamp material in vice with a minimum of .800" above the vise jaws.
 3. Load in the Euclid block program from the ProtoTRAK SM (or ProtoTRAK Edge 3) flash drive. For SM, the part number is euclid.PT4, which is found under the PT4 folder followed by the SWI TEST PROGRAMS folder. For PT3, the part number is 99999999.MX3 (or 99999999.MX2), which is located on your parts disk.
 3. Use an edge finder to set Absolute 0 on X and Y. Absolute zero is the front left corner of the block as viewed from in front of the machine.
 4. Load the .750 end mill and set Z Absolute 0 at the top of the part, and set Z reference positions in the SET UP mode. Set Z-retract a few inches above the part.
 5. Begin to run the program. The part will be machined in the following sequence:
 6. After the program run, the program will locate to the following position.
 - X = 1.318
 - Y = 1.318

#	Event(s)	Description	Depth of Cut
1		circle pocket – cuts middle circle	-0.250"
2		circle frame – cuts outer 1.830 diameter circle	-0.250"
3		circle frame – cuts material from corners remaining on Euclid block	-0.250"
4		roughs material in upper right-hand corner	-0.500"
5-12		cuts triangle on Euclid block	-0.500"
13		rectangular frame – cuts outer 2.750" rectangle	-0.7500"

7. Mount a dial indicator in the quill and check the circles.
8. Check the runout of the sides of the square frame.
9. Inspect the machined surfaces for smoothness.

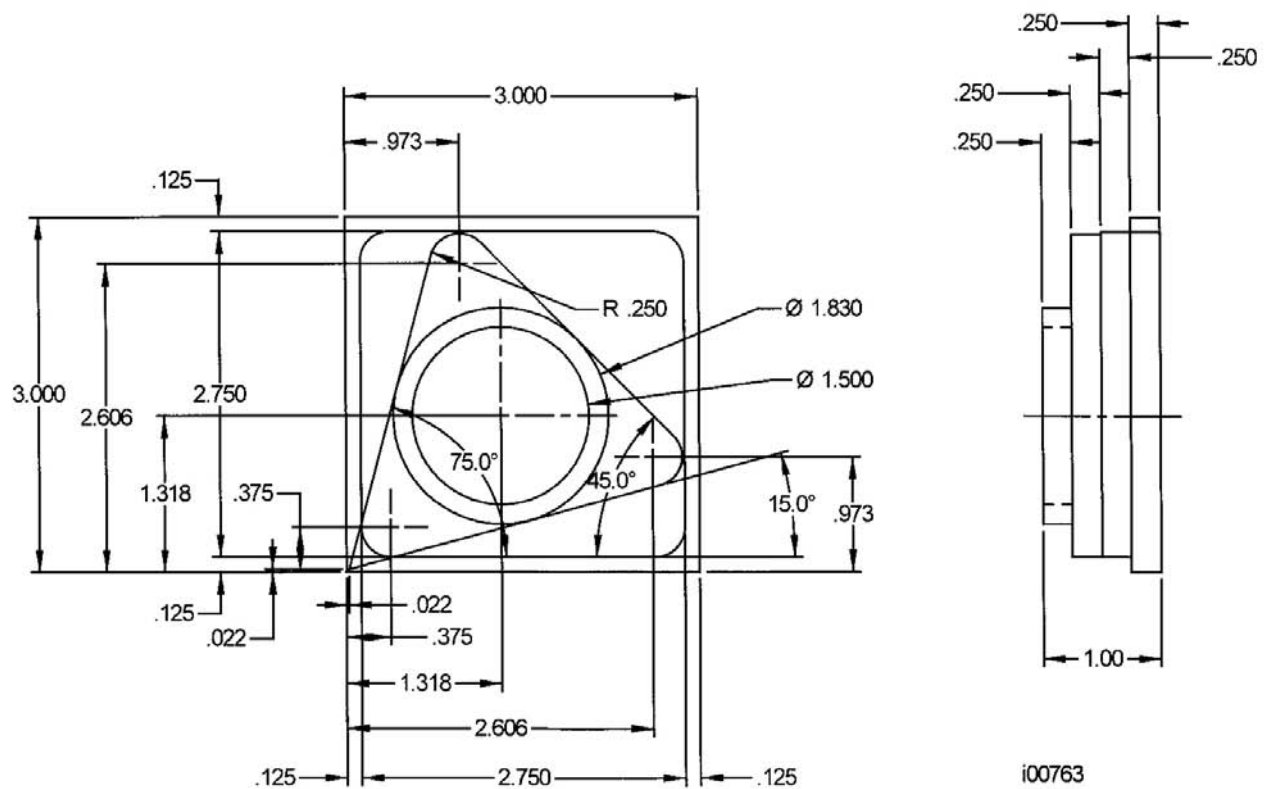


Figure 2-31
Euclid Block

3.0 Troubleshooting by Symptom

Use this section to begin the process of resolving a service problem. Each symptom type is described in a few words and then more fully described in an explanatory paragraph. Following this is a chart that directs in the most logical steps.

3.1 Problems Relating To Machining Results

3.1.1 Poor Finish

The part finish is marred with scallops or is very rough.

Perform the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 11** Measures backlash in the system (Only used on Dual-feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measures backlash in the system (Only used on Single-feedback systems)
- **Code 128** Enter backlash compensation (Only used on Single-feedback systems)

Possible Cause	Check This
Too much backlash entered for Code 128 or calculated with Code 11.	Verify nothing is mechanically loose and the backlash values are not higher than what physically is in the system.
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Check the condition and type of cutter being used, type of material, RPM and Feedrate, etc. See Machine Tool & Setup Section 4.1
Table, Saddle, or Ram Locks are locked	Make sure the Table, Saddle, and Ram Locks are unlocked. Never use gib locks with a CNC machine.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs. See X, Y, and Z-axis Gib Adjustments in Section 5.2.1.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Way surfaces are pocked, scarred, or excessively worn	Visually check the condition of all the Way surfaces. For machines that may have excessively worn Way surfaces you may need to adjust the Gibs in this area. This will affect performance when using the machine outside of this area. Check lubrication to affected areas.

3.1.2 Circles Out of Round

Circles are not round within 0.002" TIR over 3.0" DIA. This is best measured by placing a dial indicator in the quill and sweeping around the part.

Note: The typical slideway-milling machine is not capable of achieving more precise results although careful adjustments to a new milling machine have produced better results. If more precise circles are required, then it is recommended to use a precision boring head/boring bar.

Perform the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 11** Measures backlash in the system (Only used on Dual-feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measures backlash in the system (Only used on Single-feedback systems)
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Torque values on X and Y-axis are too high.	Make sure torque is lower than 20 in-lbs. Normal values for a machine that is aligned and adjusted properly should be between 10 and 15 in-lbs. Make sure torque is consistent across axis travel.
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup - Section 4.1
Machine not level	Verify that the machine is level to specification.
Head is not Trammed	Verify that the Head is Trammed to specification. See Trimming the Head
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants – Section 5.2.2
Where applicable, TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Sections 4.6 & 4.7.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Head Bolts are loose	Verify that all the head bolts are tight.

3.1.3 Taper Cut on a Programmed Straight Line Move

An unwanted tapered cut occurs, when the machine is programmed to move in a straight line along either the X or Y-axis. The DRO shows motion of a few thousandths of an inch in the axis that is not supposed to be moving.

Explanation: For straight line cuts along the X or Y-axis, the control is designed to lock the motor of the axis that is not moving. A taper is created when there is play in the system. The force of the tool shoves the table or saddle out of position.

The system will respond to being pushed out of position by making an adjustment at the end of the move.

An unwanted tapered cut is the result of looseness in the system.

Perform the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 11** Measure's the backlash in the system. (Only used on machines with Dual-feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measure's the backlash in the system. Only used on machines with Single-feedback
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 4.1
X, Y, and Z-axis Gibs are loose	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. See Section 5.2.1
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.1.4 Parts Have Incorrect Dimensions

Parts are being machined with dimensions that are different than those programmed. Typical accuracy expectations should be:

- **Circles:** 0.002" TIR over 3.00" DIA
- **Positional Accuracy:** 0.0005"
- **Repeatability:** 0.0005"

Note: The typical slideway-milling machine is not capable of achieving more precise results although careful adjustments to a new milling machine have produced better results.

Furthermore, the system should be expected to repeat within the resolution of the displayed DRO numbers of 0.0005".

Perform the following Service Code:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 123** Calibration
- **Code 11** Measure's the backlash in the system. (Only used on machines with Dual-feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measure's the backlash in the system. Only used on machines with Single-feedback
- **Code 128** Enter backlash compensation

3.1.4.1 Every Part Has the Same Error

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 4.1
Programming Error	In the program, look for common errors in programming such as transposing numbers, tool diameters, and pressing INC SET when ABS SET is meant. This is especially suspected if the dimensional errors are larger than a few thousandths. See the Controls Programming, Operations and Care manual.
Configuration file that contains calibration file and backlash constants has been erased or corrupted.	Verify configuration file (Code 313) does not read default values. Load saved configuration file from floppy disk in electrics cabinet with Code 141.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants – Section 5.2.2

3.1.4.2 The Dimensional Errors Are Random or Accumulate in Size Over the Part Program Run

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 4.1
Where applicable, TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Sections 4.6 & 4.7
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.2 Problems Regarding the Motion of the Machine

3.2.1 Run Away Axis

The axis makes an unwanted move at rapid speed in one direction and faults out. This is usually caused by an encoder signal being interrupted.

Perform the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting properly

Possible Cause	Check This
Where applicable, Sensors or Glass Scales are counting in opposite direction of motor encoder	Reverse directions with codes 321 and 322 – SM Code 97 for M, A.G.E., MX, Edge Control
The home positions or tools are not set correctly	See the Controls Programming, Operations and Care manual.
Where applicable, Sensor or Glass Scale is not reading	See TRAK Sensors or Glass Scales diagnostic Section 4.6 or 4.7
Bad Motor Encoder	See Motor Diagnostics Section 4.4

3.2.2 Slow Down Axis

The axis slows down and moves at a feedrate that is lower than rapid or than the programmed feedrate.

Perform the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting
- **Code 129** Set's the maximum allowable arc accuracy error. This applies to arcs only

Possible Cause	Check This
The maximum allowable Arc Accuracy is set too low.	This value will only slow down the machine during arc moves. The factory default is set at 0.001". Perform Code 129 to check or change this value. See Service Codes – Section 4.9
Incoming AC voltage is inadequate	Perform Code 100. See Service Codes – Section 4.9 and Electrical Section 4.8
Table, Saddle, or Ram Locks are locked	Make sure the Table, Saddle, and Ram Locks are unlocked.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures.
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Servo Drive failure	See Servo Driver Section 4.5
Motor failure	See Motor Diagnostics – Section 4.4

3.2.3 Axis Will Not Jog

The system powers up but will not respond to the jog command.

Perform the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
E-Stop is pressed in	Check E-Stop. Especially if both axes will not jog
Servo Drive failure	Especially, if only one axis will not jog; See Servo Driver Section 4.5
Shorted motor	See Motor Diagnostics Section 4.4
Poor cable or wiring connections	See Electrical Connection Section 2.12
Computer/Pendant failed	See Computer/Pendant Diagnostics Section 4.3

3.2.4 Axis Motor Motion is not Smooth

While under motor power, the motion is not smooth. The motion appears to be "rough" or jerky".

Perform the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 11** Measure's the backlash in the system. (Only used on machines with Dual-feedback systems)
- **Code 12** Feed Forward Constant. High feed forward constants will cause an unstable servo system
- **Code 127** Measure's the backlash in the system. Only used on machines with Single-feedback
- **Code 128** Enter backlash compensation
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting

Possible Cause	Check This
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures.
Where applicable, TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Section 4.6 & 4.7
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants – Section 5.2.2
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.2.5 Vibration in Motion

While axis is moving there is vibration or noise coming from the X or Y-axis.

Perform the following Service Codes and procedures:

- **Code 11** Measure's the backlash in the system. (Only used on machines with Dual Feedback systems)

- **Code 12 Feed Forward Constant.** High feed forward constants will cause an unstable servo system
- **Code 127** Measure's the backlash in the system. Only used on machines with Single-feedback
- **Code 128** Enter backlash compensation
- **Code 123** Calibrate

Possible Cause	Check This
Too much backlash entered in Code 128 or Code 11.	Recheck the machine's backlash.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures.
Gibs not making good contact.	Pull gibs out and mark with a blue die to check where the gibs are making contact. It is recommended that the gibs uniformly contact at least 80% of the surface.
Binding or looseness in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding or looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Axis Motor belt too tight.	Loosen belt.
Misalignment of ball screw	See Mechanical Drive Train (X, Y) Section 4.2

3.2.6 Searching Axis

The handwheels are slowly turning back and forth when the servos are engaged. Several thousandths of motion are observed on the vernier dial and the frequency is one cycle every couple of seconds.

Perform the following Service Code and procedures:

- **Code 11** Measures backlash in system. (Used only with glass scales and sensors.)
- **Code 12** Sets a feed forward power constant to drive axis motors
- **Code 127** Measure's the backlash in the system. Only used on machines with Single-feedback
- **Code 128** Backlash compensation on Single-feedback machines

Possible Cause	Check This
Most often caused by excess backlash compensation	Check physical backlash in system and re-enter in Code 128. Run Code 11 on dual-feedback machines
High feed forward values	Check ball screw torque. Typical code 12 values should be between 10 to 15 in-lbs.
Excessive friction in the sliding ways	Lubrication, gib adjustments, gib locks. See Machine Tool & Setup - Section 4.1
Looseness in the drive train	The drive train of the axis that is searching, especially the tightness of the drive assembly. See Mechanical Drive Train (X, Y) - Section 4.2

3.3 Problems Relating to the Operation of the Control

3.3.1 Display Blanks

The display is completely blank.

Possible Cause	Check This
Where applicable, System flash drive loose	Make sure flash drive is seated properly. SM only
Screen saver has been activated	Press any key to turn back on. All LED keys on pendant will blink when the screen saver is on. Press any key to deactivate. Hitting this key will not activate any feature on the control.
The system has shut down	Turn the power switch off; check the computer/pendant fuses and cable connections. SM only See Electrical Section 4.8
Poor cable connection from Computer Module to LCD (Liquid Crystal Display)	Double-check the connection from the computer module to the LCD.
Fuse blown in pendant	Remove fuse and check continuity
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.2 Bad Picture on the Display

The display has strange characters, horizontal bars or other unfamiliar images, or the display continually rolls.

Possible Cause	Check This
Poor cable connection from Computer Module to LCD (Liquid Crystal Display)	Check connections on computer module. SM only
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.3 Keyboard Lockup

The screen display is normal, but the system will not respond to key presses. Perform the following Service Codes and procedures:

- **Code 81** To check if the pendant keys are working properly, press each key. If the key is working, the corresponding key on the screen will light up. The pendant will also beep. SM only

Possible Cause	Check This
Logic Cable Test	Unplug logic cable and look for 9 bars on screen.
Voltage drop/spike has occurred	Shut down the system and wait 10 seconds to reboot the system.
Remote Stop-Go (RSG) switch has a short (if connected)	Remove the RSG. Turn the system off and then on again. If the problem goes away and then re-appears when the RSG is plugged-in, replace the RSG.
Poor cable connections from the Computer Module to the Distribution Board and from the Distribution Board to the Keyboard	Re-seat cable connectors by pulling out and pushing back in.
Computer/Pendant failed	See Computer/Pendant Section 4.3
Where applicable, Electromagnetic interference has entered through the	Especially suspected if the network cable is run near any electrical conduit. If the problem is chronic,

network cable (if connected); especially if intermittent	remove the cable for a while to see if there is a difference.
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3.3.4 Fault X, Y or Z

The program run or jogging operation is interrupted with a Fault Message on the display.
Note: EDGE, MX2 & AGE 2 do not have computerized Z-axis control.

Perform the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measure's the backlash in the system. (Only used on machines with Dual-feedback systems.)
- **Code 12 Feed** Forward Constant
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Cable connection problems	Check umbilical 1 and 2. Check #1 for X and Y-axis problems and #2 for the Z-axis.
Table, Saddle, or Ram Locks are locked	Make sure the Table, Saddle, and Ram Locks are unlocked. High torque on any axis may cause faulting problems during alignment routine.
X, Y, and Z-axis Gibs are adjusted extremely tight	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. See X, Y, and Z-axis Gib Adjustments Section 5.2.1
Excessive friction in the slideways	See Machine Tool & Setup Section 4.1
Binding or looseness in the Drive Train	See Mechanical Drive Train (X, Y) Section 4.2
Incoming electrical power	Incoming voltage. See Electrical Section 4.8
Measurement system not functioning properly	See Section 4.6 or 4.7
Servo Drive failure	See Servo Driver - Section 4.5
Motor failure	See Motor Diagnostics, Section 4.4
Computer/Pendant failure	See Computer/Pendant Diagnostics, Section 4.3

3.3.5 Problems Reading the Floppy Disk; Programs Not Saved Properly; The floppy drive will not read or write programs from a disk.

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
Floppy Disk failure	The Floppy Disk may be bad. See if the Floppy Disk can be read by a Personal Computer. Does the green light on the floppy drive come on when you access the disk? If so, power is getting to the floppy drive. If not check connections of floppy drive inside the computer module. See Computer/Pendant Section 4.3 for more information.
Floppy Disk full	Put the Floppy Disk into a Personal Computer to see how many bytes remain. A floppy can typically hold 1.4 MB of information.

3.3.6 System Will Not Turn On or Boot-Up

Nothing happens when the switch is turned on or the system does not boot-up.

Possible Cause	Check This
110 V line is not plugged in	Check incoming 110 V power source to black electrical cabinet
Pendant On/Off switch is Off.	Check the Pendant On/Off switch
Fuse blown in pendant or electrical cabinet	Remove fuses and check continuity.
Where applicable, Flash Drive failure	When the Computer Module starts the boot-up process, look at the 8 th line on the Display Screen. If the Mother Board of the Computer Module is communicating with the Flash Drive you will see "Detecting IDE Primary Master...Scan Disk SDCFB-64". If the Mother Board of the Computer Module is not communicating with the Flash Drive you will see "Detecting IDE Primary Master ... None". Also, check the wiring connection between the Flash Drive and the Mother Board. See Computer/Pendant Diagnostics Section 4.3 SM only
Computer/Pendant has failed	See Computer/Pendant Diagnostics Section 4.3

3.3.7 System Reboots by Itself

During operation, the screen suddenly blanks and then shows that the system has begun the boot-up sequence.

Possible Cause	Check This
Interruption of 110 V power to pendant	Using a Voltmeter, check the incoming 110VAC to the pendant.
Poor wiring and cable connections	Check for any loose wiring or cables
Computer/Pendant failed	See Computer/Pendant Diagnostics Section 4.3

3.3.8 System Shuts Off

During operation, the system shuts off and will not turn back on.

Possible Cause	Check This
Fuse blown in pendant	Remove fuse and check continuity
Poor wiring and cable connections	Check for any loose wiring. Also, check the 110VAC Power Cable connection from the 110VAC Power Strip to the Pendant. See Electrical Section 4.8
Flash disk failure	Remove and reseal the flash disk
Computer/Pendant has failed	See Computer/Pendant Diagnostics Section 4.3

3.3.9 Will Not Hold Calibration

The control will not hold calibration. Go to the "Configuration Values" screen and write down the calibration values for the motor encoders (Encoder) and the position feedback encoders (Scales). The calibration values are written in Hexadecimal. Recalibrate the system and see if the values change. Turn the system off and on and see if the values are held.

Perform the following service codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 313** Configuration Values
- **Code 123** Calibration Mode

Possible Cause	Check This
Configuration file corrupt	Load default configuration by going to code 313
Not saving Calibration values	Replace Computer/Pendant module. See Computer/Pendant

If calibration factors are being saved, but the measurements are not repeating or are not accurate:

- See "Measurements Are Not Repeating"
- See "Measurements Are Not Accurate"

3.3.10 Auxiliary Functions Not Working (TRM not applicable)

3.3.10.1 AGE 3, MX3 & M3 Controls (where applicable)

The auxiliary functions will not turn on or off at the programmed times. There are 4 auxiliary functions:

1. VAC - coolant pump
2. Activates a solenoid for an air mister
3. Electrical signal to activate Haas Indexer
4. Spindle on and off

Run the following service code and procedures:

- **Code 200** Auxiliary Function Test

Code 200 will turn on and off the auxiliary functions.

To test the auxiliary functions enter Service Code 200 and press INC SET. Check the LED lights in the electrics box. For example: press auxiliary function 2, then press Turn On, the corresponding LED light should come on and you should hear the air mister solenoid engage. Press RSTR, then press Turn Off and LED should go off and the solenoid should disengage. See Section 4.10 for the explanation of the LED lights.

Possible Cause	Check This
Auxiliary functions malfunction	Check lights on electrics box. See Red LED Diagnostics Lights Indicator – Section 4.10 If lights are not on, replace electrics box.
Coolant and air are not connected. Coolant line clogged	Check coolant and air lines.
Spindle will not turn on Voltage problem 220/440V	Check voltage with a voltmeter.

3.3.10.2 SM Controls (where applicable)

The Auxiliary Functions will not turn on or off at the programmed times. There are 3 Auxiliary Functions:

1. Activates or deactivates a "110VAC Receptacle" typically used for a coolant pump or solenoid for mister.
2. Sends an electrical signal to rotate the turret on a "Haas Indexer".
3. Turns the "Spindle Off" at the end of a programmed event.

In order to run the above auxiliary functions in run mode the accessory key on the front of the pendant must be in the AUTO mode.

All of the auxiliary function signals are carried down to the cable breakout box through umbilical #2. Each function then has its own relay inside this box. If one of these relays fail then these features will not work.

Perform the following service code and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.

Possible Cause	Check This
Bad 110VAC "Coolant or solenoid" receptacle fuse	Check if the fuse light indicator next to the plug is lit. Verify that the fuses are good or bad by checking the resistance of the fuses using an Ohmmeter.
Poor cable connections	Check all the cable connections on the cable breakout box, Coolant Pump, and Air Solenoid (Located on the Air Regulator). In particular check umbilical # 2 cable, which carries the auxiliary function signals.
Faulty "Indexer" connector	Check for continuity between pins 3 and 4, when the output of the Haas Indexer connector is activated.
Bad cable breakout box	Check 110 V power coming out of the AC E-stop port with the E-stop in the out position. This will cause the spindle to not run.

3.3.11 E-Stop Error

The E-Stop turns the power off to the axis and spindle motors. This is done by breaking the 110 V contact.

Spindle Motor Electrical Box

110V Power reaches the electrical box through the AC E-stop cable. It is used to energize the spindle motor contactor. If this contactor is not energized, the spindle will not turn on.

If the E-Stop button is depressed, and no message is displayed on the screen, either the E-Stop button or the Computer Module is at fault.

Possible Cause	Check This
Faulty E-Stop switch	Check the cable connections from the computer module to the E-Stop switch. Check the E-Stop switch for functionality.
Bad pendant	Does 110 V power come out of the cable breakout box power cord on the pendant? If yes, and the screen has an E-stop message, replace the pendant.

3.3.12 Limit Switch Error - Optional

Limit switches are installed on the table, saddle, and ram to prevent serious damage to the machine in the event of a crash. In the event a limit switch is triggered, a limit switch error will appear on the screen.

Critical Error 64: Servo Error
X-axis Limit Switch
Correct the fault condition and continue.

To return the machine to its normal state of operation, perform the following procedure:

1. Use mechanical handwheels on X and Y to move switch off the trigger. For the Z-axis, manually lift the arm on the trigger to return the limit switch to its normal position. Then jog the ram up or down as necessary.
2. Press the "Mode" or "Return" key to reset the control
3. Press the "DRO" key to enable the machine to once again jog.

Possible Cause	Check This
Limit switch jumpers in cable breakout box are making poor contact.	Remove and reseat jumpers.
Limit Switches are triggered	Reset the Limit Switches using the procedures described above.
Poor Limit Switch Cable connection	Check for any pins that are loose, pushed in, or bent. Verify that there is a good connection between the cables on the cable breakout box.
Limit Switch failure Try this Switch 2 limit switch cables on the cable breakout box.	Does the limit switch problem move to the other axis? If it does then the switch is most likely the problem. If it stays with the original axis then it could be the cable breakout box.

3.4 Problem with the Measurements

3.4.1 X, Y and Z-Axis Measurements Do Not Repeat

With a dial indicator mounted to the bottom of the spindle, touch off a fixed surface either in the X or Y-axis direction and then set the DRO equal to 0. Crank away several inches and then touch off again at the same place. If the reading has not returned to 0

on the DRO, zero the display and repeat the procedure. If the measurement does not repeat, you have a repeatability problem that must be resolved.

Test for accumulative error by moving the axis a number of times to see if the error gradually grows by a small amount. If so, it may be caused by a misaligned sensor or scale. If the error abruptly changes by a large amount, it may be caused by a bad encoder.

Expected repeatability numbers should be 0.0005" or less.

Perform the following service codes and procedures where sensor/glass scales are used:

- **Code 304** Toggle X sensor/glass scale on/off – SM only
- **Code 305** Toggle Y sensor/glass scale on/off – SM only

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Make sure there is sufficient contact between the tool holder and the spindle. See Machine Tool & Setup Section 4.1
X, Y, and Z-axis Gibs are loose	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures.
Where applicable, TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. Use service codes 304 for X and 305 for Y to turn off the suspect encoder. Does problem still exist after turning it off?

Possible Cause	Check This
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Encoder Disk or Reader Head on motor are loose	Swap the motor in question with a known good motor. For example, swap the X-axis motor with the Y-axis motor. If the symptom stays with the motor in question, then replace the motor. If not, then the motor is not at fault and something else is causing the problem.
Spindle and/or Quill are loose	Use a Dial Indicator and check for side-to-side movement between the Spindle and the Head. Next, check for side-to-side movement between the Quill and the Head. There should be no more than 0.0003" of side-to-side movement. Make sure that there is a few thousandths gap between the Spindle Collar and the Quill after tightening.
Head bolts are loose	Tighten Ram bolts

3.4.2 X, Y, and Z-Axis Measurements are not Accurate

Measurements repeat, but with a dial indicator mounted to the bottom of the spindle, traversing the length of a gage block or some other measurement standard, the measurement is not accurate.

Note: If your part has incorrect dimensions, see Parts Have Incorrect Dimensions, Section 3.1.4.

Note: First check for repeatability of the DRO: With a dial indicator mounted to the bottom of the spindle, touch off a fixed surface either in the X, Y, or Z-axis direction and set the DRO equal to 0. Crank away several inches and touch off again at the same place. If the reading has not returned to 0 on the DRO, zero the display and repeat the procedure. If the measurement does not repeat, you have a repeatability problem that must be resolved before the accuracy problem can be resolved. See Measurements That Do Not Repeat, Section 3.4.1.

Possible Cause	Do This
The Calibration is incorrect	Recalibrate the machine. See Calibration & Backlash Constants – Section 5.2.2
Incorrect backlash values	If the machine does not repeat bi-directionally check the backlash on the axis in question. See Section 5.2.2.

3.4.3 The DRO is not Counting

The DRO for one axis is not counting when an axis is moved. Often times if this is the case the axis will fault. See Faulting Axis Section 4.7.1

Perform the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- **Code 304 & 305** Turns off X and Y sensor or scale where applicable. SM control only

Possible Cause	Check This
Servo driver failure	See Servo Driver Section 4.5
Motor Encoder not counting	See Motor diagnostics (not applicable with Glass Scale option)
Glass Scale or Sensor Failure	Does axis now count? If so, replace scale.
Computer/Pendant failure	See Computer/Pendant diagnostics

3.4.4 X, Y, and Z-Axis DRO Counting in Wrong Direction

The DRO is counting in the wrong direction.

The positive directions for each axis are:

- **X-axis** – Table moves to the left
- **Y-axis** – Saddle moves toward the front of the machine
- **Z-axis** – Ram moves up

Perform the following service code and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 313** Check the line that specifies the product.
- **Code 97** Axis configuration

If the product does not match the machine, the machine ID key will need to be replaced.

3.4.5 X, Y, & Z-Axis Electric Handwheels Count in Wrong Direction

The Electric Handwheels turn in the wrong direction.
The positive directions for each Electric Handwheel are:

- **X-axis** - Electric Handwheel turns clockwise
- **Y-axis** - Electric Handwheel turns counterclockwise

Perform the following service code and procedures:

- **Code 308** Reverse X-axis Handwheel Direction – SM only
- **Code 309** Reverse Y-axis Handwheel Direction – SM only

3.5 Problems with the Machine Tool

3.5.1 Z-Axis Noisy

While jogging or cutting in the Z-axis direction, the axis makes unusual noises. See below for head noise.

Possible Cause	Check This
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 4.1
Ram Locks are locked	Make sure the Ram Locks are unlocked.
Inadequate or no Lubrication to the Ballscrew and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
Z-axis Gibs are not adjusted properly	Check the adjustment of the Z-axis Gibs using the Z-axis Gib adjustment procedure. See Z-axis Gib Adjustments Section 5.2.1
Mechanical Drive Train	Misalign ballscrew, or top and lower bearing failure.
Z-axis motor failure	Replace Z-axis motor See Motor Diagnostics Section 4.4

3.5.2 Spindle Stalls or Turns-Off During Machining

During machining, the spindle turns off and loses power. First check incoming voltage and connections.

Possible Cause	Check This
Machine Tool and Setup problem	Check the type of material being cut, type and size of cutting tool, RPM, and Feed rate. Also check the condition of the cutter to verify that the cutter is not dull. See Machine Tool & Setup Section 4.1
Drive Belt in the head is slipping	Check the alignment, condition, and tension of the Drive Belt.
Cut more than the machine is capable	Check width and depth of cut

3.5.3 Spindle Motor Hums or Will Not Run

The spindle motor makes a constant humming noise during operation or will not turn on.

Sport and SM models only: If the spindle does not run, you must make sure 110 V power is reaching the spindle motor contactors in the electrics box. Check your 110V power across terminals wire 3 and ground. If power is not reaching the electrical cabinet, but is reaching the cable breakout box, then most likely a relay has failed in the cable breakout box. The cable breakout box will need to be replaced. This relay is in series with the 110 V power in the E-stop circuit. See Section 3.3.11. If power has reached the electrical box then use the schematic in Section 4.8 for how the power is routed.

Possible Cause	Check This
Wrong voltage	Check the 220V/440V voltage to the machine
Poor wiring connections	Check all the wiring connections to the electric's box.
Defective cables or poor cable connections	Check all cable connections
Spindle Motor is bad	Check the resistance of the Spindle Motor windings on the Spindle Motor between L1 & L2, L2 & L3, and L1 & L3, using an Ohmmeter. The resistance should range from ".7 to 1.2 Ohm" for the DPMS3, from ".5 to .9 OHM" for the DPMS5, and from 1.0 to 1.8 for the DPME2. If the Ohmmeter reads "0 Ohms" or "OL", replace Spindle Motor. Next, check the resistance between L1 & Ground, L2 & Ground, and L3 & Ground, using an Ohmmeter. The resistance should read "OL". If not, replace Spindle Motor.
Spindle will not run because 110 V power is not reaching the spindle contactor	Check 110 V coming out of the AC e-stop port on the cable breakout box. Relay failure in cable breakout box. Replace cable breakout box – Sport and SM.

3.5.4 Spindle Runs Backwards

The spindle motor runs in the opposite direction. The spindle will run in opposite directions from high to low gear.

Possible Cause	Check This
3-Phase wires backwards	Need to switch any 2 of the 3 wires either coming into the machine or motor. Note: Caution: Be sure to shut off all power to the machine before attempting to switch any wires.

3.5.5 Spindle motor intermittently stops and starts or does not operate

Possible Cause	Check This
In spindle control electrics box, loose screws holding the spade lugs down to the FWD/REV relays, causing intermittent contact.	Ensure that the screws on the FWD/REV relays are holding down the spade lugs and that the screws are tight.
In spindle control electrics box, FWD/REV contactor-wiring spade lugs installed improperly, causing loose contact or burned wires.	Ensure that the spade lugs are installed back to back on the FWD/REV relays, that the screws are tight, and that the spades are fully locked beneath the hold-downs.

3.5.6 Head Noise

Head noise pertains to any unusual noises coming from the head under load and no load situations. Most often head noise will only be noticeable under load situations. It is important to try to distinguish between problems with components in the head versus problems caused by the setup or tooling being used on a particular job. Use the table below to try to pinpoint the possible cause. Also try to pinpoint the noise by seeing if it exists in high, low or neutral. For example, if the noise is evident in neutral then this eliminates the spindle bearings.

Possible Cause	Check This
Machine setup or tooling problem	If the noise is most evident under load (cutting situations) then it is important to look at setup and tooling being used. Ask the following questions. Is the cutter dull? Is the tool loose in the holder? Am I taking a bigger cut than is possible on the machine? Is the part moving in the vice? Am I using realistic speeds and feeds? Any one of these can have a significant impact.
Upper spindle bearing is worn out.	Remove the upper bearing plate above the spindle. This will unload the bearing. If the noise goes away then this bearing should be replaced.
Verify nosepiece is tight on bottom of spindle.	To check if the nosepiece is bottomed out try to insert a piece of paper in between the nosepiece and the quill. If a piece of paper does fit then this may be the problem. Before tightening or loosening the nosepiece make sure to loosen the setscrew that holds it in place.
Spindle bearings are worn out	This is categorized by a high pitch sound and is most evident at high RPM's. It should also cause chatter under load. Replace the spindle if this is the case. See spindle replacement in Section 5.

4.0 Diagnostics

This section explains the diagnostic procedures used to isolate service problems.

4.1 The Machine Tool & Set-Up

4.1.1 The Milling Machine Checklist

The following is a quick reference for the types of problems that may arise if problems are noticed in these areas.

Problems With:	Can Contribute To:	Most Suspect When (and why):
Spindle bearings See Spindle Replacement	Noisy head Poor finish Circles out of round	Older machines, machines that are pushed hard
Lubrication system	Premature wear of ball screws, wear surfaces Poor finish	New installations (may not be hooked up or line sheared)
Inadequate lubrication habits	Premature wear of ball screws, wear surfaces Poor finish	New installations (more motion than the machinist is used to with a manual mill) Lubricate machine every morning before use.
Gib locks - on X and Y axis	If locked can lead to axis faults.	<i>Note: when using the CNC to machine, never tighten the gib locks!</i>
X and Y gibs loose See Gib Adjustment - Section 5.2.1	Taper on straight Y moves Poor finish Circle out of round	When machine hasn't been serviced in a long while.
Gibs too tight	Not getting to position, does not repeat, axis faults Poor finish	N/A
Gibs floating	Not getting to position, does not repeat, axis faults Poor finish	Contact area of gibs. May need to be scraped. Very old machines may not have any more adjustments on gib. A new gib will need to be fit on the machine.
Gibs defective - bowed, scarred	Excess play when gib is checked side to side	Inadequate gib contact
Way surfaces pocked, scarred, or excessively worn	Poor finish Out of round circles Faulting	Inadequate lubrication
Ram gibs loose	Parts incorrect dimensions Head out of tram in Y direction.	Vibration or jerky motion in Z axis
Machine not level Weight not distributed evenly on all six screws See Leveling procedures	Parts incorrect Machine geometry off, i.e. tram.	New installation or heavy crash.
Head out of tram See Tramming Head - Section 5.2.3	Leaves uneven surfaces on bottom of pockets.	Machine not level, ram gibs loose.

4.1.2 A Special Word About X/Y/Z Gibs

The slideway surfaces are vital to the performance of the bed mill.

Gibs should be:

- flat
- free of twist
- free of burrs
- free of blockages in the oil passages and channels

Defective or scarred gibs must be replaced. Shimming of gibs will not yield acceptable results.

It is good machining practice to avoid the use of shop air to clean the chips off a machine. This risks blowing chips into the sliding way surfaces and compromising the performance of the machine.

Gibs that are not adjusted correctly will affect the performance of the machine. It will lead to positioning and repeatability problems. The gibs should be adjusted at least twice a year.

See Gib Adjustments Section 5.2.1.

4.1.3 Lubrication

Lubrication is one of the single, most important maintenance issues and plays a key role in assuring the performance and durability of the bed mill. At the beginning of each day manually supply oil to the way surfaces.

Lack of lubrication can lead to a variety of problems with your machine motion due to increased friction in the sliding ways. This increased friction may lead to part inaccuracies and decreased life expectancies of your ball screws and way surfaces.

4.1.4 Machining Set-Up

The machining set-up can greatly influence the performance of your mill. Be aware of the following:

Problems With	Can Contribute To:
Feed and Speeds (spindle rpm) See below	Poor finish Machine chatter Excessive speeds and feeds can break cutting tools or wear tools prematurely.
Tooling Using the wrong cutter for an application Entering the wrong size diameter and programming with tool compensation.	Poor finish Parts incorrect size
Cutting too deep	Part dimensions incorrect Driving and cutting forces cause deflections, since no material is totally rigid Machine chatter
No coolant	Poor finish, decrease the life of the cutter

4.1.4.1 Spindle Speeds

Spindle speeds are influenced by a number of variables:

- Material
- Rigidity of the Machine Setup
- Coolant
- Cutter type, material and diameter
- Cutting Depth

As a general rule:

- Lower spindle speeds are used to machine hard or tough material or where heavy cuts are taken.
- Higher spindle speeds are used to machine softer materials in order to achieve better surface finishes. Higher speeds also apply when using small diameter cutters for light cuts on frail work pieces and delicate setups.

Note: Cutter diameter greatly affects spindle speeds. The larger the diameter, the lower the spindle speed.

4.1.4.2 Feedrates

Factors that affect feedrates:

- Depth and width of cut
- Design or type of cutter
- Sharpness of the cutter
- Workpiece material
- Type of finish or accuracy required
- Climb or conventional milling

If a fine finish is required, reduce the feed rather than increase the spindle speed. Cutters are dulled by higher spindle speeds rather than high feedrates.

4.2 The Mechanical Drive Train (X, Y)

Indications:

- Troubleshooting instructions indicate that the drive train is potentially the problem and other (more easily checked variables) have been exhausted.
 - Roughness, looseness, tightness or jamming movement in the table or saddle.
1. Check for machine considerations, especially gib locks and gib adjustments. See Gib Adjustments Section 5.2.1.
 2. Check the torque of the axis in three places (both ends and center of ball screw) along the length of the ball screw. The torque should be within 2 or 3 in-lbs across the length of the ball screw. If it is not, chances are the ball screw is misaligned. A misaligned ball screw can lead to parts being out of round and servo problems at low feedrates. A bad ball screw can also cause high torque, although this is highly unlikely. See Sections 4.2.1 for more information.

Note: The following steps take you in logical sequence through the assemblies. For drawings of these assemblies see Figures 5-12 through 5-25 in Section 5. These instructions break the machine down from fully assembled and point out the areas to look at specifically.

3. Check that the belt is properly tightened. A loose belt can lead to excessive backlash compensation values on motor encoder only machines.
4. Check that the nut that tightens up against the ball screw pulley is tight. If this is loose the pulley may not run true on the ball screw.
5. Check that the tapered sleeve that seats the pulley has not clamped to the ball screw prematurely. It should be seated firmly against the pulley. Tightening the nut may not have ensured this. Also make sure the pulley is keyed to the ball screw.
6. X-axis for all models - Ensure that the screws that hold the bearing housing in place to the bracket are not loose.
7. Y-axis - Ensure that the bearing housing is clamped in place by the bracket. This design uses the bracket to secure the bearing housing in place. It should not allow the bearing housing to float between the bracket and machine.
8. Ensure that the Clamp Nut is secured. The following applies to the clamp nut:
 - When loosening, make sure to back out the 10-32 screw from the clamp nut.
 - When tightening, snug the 10-32 screw so the clamp goes onto the ball screw thread with some drag. Thread it onto the ball screw and torque the clamp nut to 50 ft/lbs and then tighten the screw down.
9. Take out the angular contact bearings and inspect them. They should roll smoothly and be lightly greased. If not, replace them. When putting the bearings back into the housing make sure to put them in correctly. Failure to do this will cause problems. The thin race of each bearing should be facing inward toward the spacer ring.

Note: the bearing housing and spacer ring are matched sets - keep them together.

10. Check the ball screw mounting to the yoke. Make sure the SHCS are tight.
11. Inspect the ball screw, ball nut and yoke for the potential problems shown in the chart on the next page.

CAUTION!
Unlike a lead screw, do not unscrew the ball screw from its nut. This will destroy the ball screw!

Potential Problem:	Check By:
Bad ball screw	<ul style="list-style-type: none"> • Visually inspecting the ball nut - if the nylon seal is broken or deformed, if contamination has visibly entered the ball nut or if balls are out of the ball nut, replace the ball screw. • Cranking the ball screw through a significant part of its travel. If it jams, feel loose or has rough spots, replace the ball screw. • Using the dial indicator on a vertical flat of the ball screw to check for backlash between the ball screw and ball nut.
Potential Problem:	Check By:
Ball nut not tightened to the yoke	<ul style="list-style-type: none"> • Inspection for space between the head of the bolt and the ball nut i.e. the retaining bolt has bottomed out in its thread and is not securing the ball nut to the yoke properly.

Yoke loose in the saddle	<ul style="list-style-type: none"> • Inspection for any motion of the yoke or looseness in the Yoke mounting screws.
Oil lines sheared	<ul style="list-style-type: none"> • Visual inspection.
Oil line blockage	<ul style="list-style-type: none"> • Pump the oil and ensure that it flows evenly to the ways and ball screw.
Ball screws not aligned properly	<ul style="list-style-type: none"> • Measure from the ball screw to the back of the saddle on both sides of the yoke (the table must be removed). The measurements must be within $\pm .005"$ end-to-end. See above explanations.

Note: Ball screws are inspected throughout their entire travel for backlash and consistent torque. A ball screw should be good for millions of inches of travel if installed properly. Do not be too quick to replace a ball screw if there is insufficient indication that it is bad; this will just be a costly delay to resolving the real problem.

4.2.1 Ball Screw Alignment

4.2.1.1 TRM, DPM, Sport B3, DPMS3, DPME2 Ball Screw Alignment

- **X-axis** – there are 3 components that can cause misalignment: the yoke, the left side bearing housing bracket, and the right side bearing housing.
- **Yoke** – the yoke is aligned at the factory and pinned in place. It is aligned to within 0.0005" with a precise alignment tool. The yoke most likely is not causing the problem. If this were the problem you would need to remove the pins and align the X ball screw with the back of the saddle. Drill new holes and pin the yoke in place. The Y-axis ball screw bore is machined perpendicular to the X bore. If the X-axis is aligned the Y-axis will also be aligned.
- **Left-side table bearing housing** – this is most likely the cause of the misalignment. To align the bracket and bearing housing, move them as close to the yoke as possible. Loosen the bracket bolts and bearing housing bolts and then retighten. This should allow the bearing housing to align itself up with the yoke.
- **Right-side table bearing housing** – once again move the bearing housing as close to the yoke as possible. Loosen the bearing housing and retighten. This should allow the bracket to align itself. If you do not move the table toward the yoke the ball screw will tend to bend down slightly and cause misalignment.
- **Y-axis** – the only component that can cause a misalignment problem is the motor mounting bracket. To align this bracket, move the saddle as far to the front of the machine as possible. Loosen the bracket and then retighten it. Once again moving the saddle forward allows the yoke to be as close to the bearing housing as possible.

4.2.1.2 DPM5, DPMS5 & Sport B5 Ball Screw Alignment

- **X-axis** – there are 3 components that can cause misalignment: the yoke, the left side bearing housing bracket, and the right side bearing housing. This machine has a separate yoke for the X and Y-axis.
- **X Axis Yoke** – the yoke is aligned at the factory. If you suspect the yoke is misaligned, the bolts for the yoke can be accessed from an opening on the bottom left side of the saddle. Break these bolts free and move the table back and forth along its travel and then retighten the bolts.
- **Left-side table bearing housing** – To align the bracket, move the yoke (table left) as close to the bracket as possible. Loosen the bracket bolts and then retighten. This should allow the bearing housing to align itself up with the yoke.

- **Right-side table bearing housing** – once again move the yoke as close to the bearing housing as possible (table right). Loosen the bearing housing and retighten. This should allow the bracket to align itself. If you do not move the table toward the yoke the ball screw will tend to bend down slightly and cause misalignment. Make sure the mechanical handwheel is not causing the misalignment.
- **Y-axis** – the only component that can cause a misalignment problem is the motor mounting bracket. To align this bracket, move the saddle as far to the front of the machine as possible. Loosen the bracket and then retighten it. Once again moving the saddle forward allows the yoke to be as close to the bearing housing as possible. The yoke is pinned at SWI should not become misaligned unless the machine has been repeatedly crashed.

4.3 Computer/Pendant Diagnostics

4.3.1 Diagnostics for Computer Modules contained in Pendant – EDGE, SM3, M3

The pendant consists of 2 separate modules: the computer module and screen/enclosure – SM and EDGE only.

In general, the pendant/computer module is best diagnosed by eliminating all other possible alternatives. The following table lists some problems and what these problems can lead to. Make sure to first unplug any accessories like the Remote Stop/Go switch, external keyboard, mouse, etc. to eliminate any interference.

Possible problems	Can lead to
Poor cable connections	There are 4 cable connections to the left side of the pendant. Make sure all cables are properly fastened. SM only
Pendant locks up	Press the E-stop button and see if lock up clears if not then do the following: Turn the pendant off, wait at least 30 seconds, and turn it back on and check to see if the malfunction has been reset.
No voltage to RSG port	RSG will not work – should be 5 DC volts present Check with a voltmeter. SM only
Low voltage to flash drive or slave board. (EDGE & M3 have no flash drive)	Can cause the system to lock up and the flash drive to act abnormally. Check voltage to power cable at flash drive module with voltmeter. It should be 4.8 DC volts and above. Lower values than this can cause problems. SM only
Where applicable, Flash disk failure	If the flash disk fails, the system will not boot up or operate. It will need to be replaced. All programs and machine configurations will be lost. Make sure to back up your flash disk from time to time.
Floppy disk failure	Will not allow user to save or pull up programs from a floppy disk. See Section 4.3.1.
LCD backlight burns out – SM only	Check all cable connections to LCD, distribution board and computer module. Make sure the power is turned off before doing so.

Possible Problems:	Can Lead to:
Overlay failure (keys on pendant)	Certain buttons on overlay do not work. Do code 81 to verify each key beeps.
Low voltage to pendant or current spikes	1 amp fuse in pendant blows. Pendant will not turn on.
Slave Board not functioning	If no slave data is found in Code 33, replace the module.

4.3.2 Diagnostics for Computer Modules Separate from Pendants – AGE2, AGE 3, MX2 & MX3

Indications:

- Problems that are manifested in the Display Pendant (e.g. Blank Screen), but the Display Pendant passes the logic cable test.
- There are problems with axis motion.

Objective:

- To determine if the computer module has failed.

Note: SWI's exchange program provides for an exchange of the entire computer module once a problem has been isolated to this subassembly. This makes it unnecessary to identify the exact nature of the failure within the computer.

1. Open the computer cabinet. Be sure to clean the area around the cabinet first so that chips are not allowed to enter the computer module.
2. Check the floppy disk drive lights. There are two drives with exception to the MX2, which has one drive.
3. Check the fuses.

Drive	How to Check	When to Check
Bottom – System disk	Turn the system off and then back on. Observe the floppy drive light as the system boots up. It should come on and stay on until the "Select Mode" or Main Menu screen appears.	Problems with the system booting up
Top – Part Programs Disk	While in the Program In/Out mode, give the system a Store or Retrieve command and observe the light. It should come on after the system command is given.	Problems loading in the part programs.

4. With the system power on, check the large orange light at the bottom left of the cabinet. This indicates whether the power strip assembly is receiving AC power.
5. Check the LEDs that are mounted to a PC board on the right side of the cabinet. These LEDs may be viewed through a slot through the black sheet metal cover. You may also remove the sheet metal cover. Use the following guidelines for diagnoses with the LEDs.

CAUTION!

The computer cabinet contains voltages that are very dangerous.

Position	Purpose	Comment
Top	Indicates power to the motherboard	Should be on whenever the system is on. If not, replace the computer module. Check to see if power is reaching the computer module.
Middle	Indicates if the system is receiving counts from the independent position encoder. (TRAK Sensor)	View the light while moving an axis of the machine using a handwheel. The LED should flicker as the axis moves.
Lower	Indicates if the slave board is sending a command to the motors. (Motor Encoder counting)	View the light while moving axes under power. The light should be on.

Failure of these lights to come on during the operations shown above indicates that the computer module should be replaced.

4.4 Motor Diagnostics

The Motor subsystem is comprised of 2 parts: The Motor Encoder and the Motor. The motors are powered by 110 VAC voltage. The servo driver is also an integral part of servo system, which is discussed in detail in the next section.

WARNING!

Do not work with the motors unless the power is disconnected from the machine. The motors are run by 110 VAC. There is possibility of death by electrocution!

Rarely do both the X and Y motor/servo systems fail at the same time and in the same way. So, if your problem is occurring on both axes, its source is probably somewhere else.

4.4.1 Cable Connections

Check the motor cable connections on the cable breakout box. Verify there are no pushed in pins on the connector.

4.4.2 To Check the Motor Encoders

If the motor encoder inside the motor has failed or is not reading the machine will fault out on that axis. Do the following to verify this problem:

Motor encoder and secondary feedback machines – run Service Codes 100. Both the motor encoder and sensor or glass scale encoder should count on the DRO screen. The motor value should be displayed under the Z-axis and the sensor or glass scale under the X or Y-axis depending on which axis you are doing.

4.4.3 Encoder Counts to Pendant

SM/M Products only – Before replacing the motor due to a bad motor encoder it is a good idea to check the cables that take those signals back to the pendant. If these signals are not getting back to the pendant then the axis will fault. Check the following cable connections.

- Umbilical #1 and #2 at the cable breakout box
- Umbilical #1 and #2 at the pendant

- Umbilical #1 carries the X and Y-axis signals and Umbilical #2 carries the Z signals.

4.4.4 Moving Problem from One Axis to Another

Another way to troubleshoot a problem with a particular axis is to swap parts from 1 axis to another to see if the problem moves. If the problem moves then that component is faulty. See the example below.

Symptom – X Axis will not move and faults

This could be due to a bad motor, servo driver, or computer module, but it is not always obvious which component is causing the problem. In order to determine which component is causing the problem try the following:

Swap these components	Results
Physically switch the X and Y servo amp	Has problem moved to Y-axis? If yes, replace amp. If no, the motor is the problem.

4.5 Servo Driver

Note: the Servo Driver is located in the black box on the side of each motor.

WARNING!

Do not work with the Servo Driver unless the power is disconnected from the machine. There is possibility of death by electrocution!

Indications:

- Problems moving just one axis, including hard turning in one direction.

Objective:

- Isolate the problem to the particular Servo Driver

Steps:

1. Turn off and unplug the system.
2. Physically swap the servo module from the axis that is not working to one that is.

Note: To avoid pulling the wires out of the connector, use the loop to pull the connector from the Servo Driver.

If the problem moves to the other axis and clears up from the original axis, replace the Servo Driver.

4.6 Glass Scales

The Z glass scale is standard with the following machines: DPME2, TRM, DPM, DPMS3, DPMS5, & Sport B3. The X and Y-axis glass scales are optional for the DPMS3 and DPMS5 machines for secondary feedback only.

4.6.1 Alignment of Scales

- **X Axis** - The X-axis scale must be aligned within 0.005" in the up and down direction over the length of the scale for proper operation. Misalignment can

cause the scale to not read in the certain areas of the scale that are not aligned with the reader head. If this happens, the axis will mostly likely fault out in this area. Also make sure the mounting hardware for the reader head is tight. Loose hardware can cause excess backlash when reversing direction.

To align the scale, place a 0.001" indicator on the bed ways and on top of the scale extrusion. Move the table along its full travel from one end to another to verify it is aligned. If the scale is misaligned loosen the 2 screws at either end to shift the scale up or down as needed. You will also need to loosen the center support bracket to allow the scale to pivot.

- **Y Axis** - The Y-axis must be aligned in the up and down direction and must be parallel to the Y-axis way surface. Both surfaces must be aligned to within 0.005". Failure to align the scale properly could cause the same problems as mentioned above. Mount your 0.001" indicator on the saddle and move the Y-axis back and forth along its travel.
- **Z Axis** – The Z scale must be aligned parallel with the quill. Make sure the gap on the readerhead is consistent along the length of travel. Align the scale within 0.005" up and down.

See Figure 5-8 for an illustration of the Z glass scales.

4.6.2 Measurements Do Not Repeat

1. Determine if the error in repeatability is random or accumulating:
 - Mount a dial indicator in the quill.
 - Touch off a fixed point on the table and set the DRO and indicator to 0.
 - Traverse away approximately 6 inches.
 - Return the touch off again at DRO 0 point.
 - Compare with indicator reading.
 - Do not Re-zero the DRO, traverse away and return several times.
 - Again, compare DRO with indicator reading.

Note: Random error will be unpredictable and give scattered readings, adding and/or subtracting the error after each traverse with no pattern. See Step 2.

Accumulating error will add roughly the same amount to the reading after each traverse. See Step 3.

2. For random error, look for problems in the set-up of the glass scale that have resulted in a loss of rigidity. Common sources of random error include:
 - Loose scale mounting hardware.
 - Loose reader head.
 - Very loose motion of the table or saddle.
3. Accumulating error is commonly the result of:
 - Scale out of parallel to the axis travel.

- Dirt or chip on the glass scale.
- Broken glass.

4.7 TRAK Sensors – TRM, DPM, & DPM5 (optional on DPMS3, DPMS5, Sport B3 & Sport B5)

TRAK Sensors are used on the X and Y-axis for secondary feedback. The following section talks about some of the common symptoms associated with a problem sensor and how to isolate or fix the problem.

Common symptoms

- Faulting Axis
- The DRO measurements do not repeat
- The DRO measurements are not accurate

Objectives:

- To determine if the TRAK Sensor is bad and needs to be replaced.
- To determine if there is a problem with the sensor set-up

4.7.1 Faulting Axis

If a sensor has stopped reading and you try to move an axis, the axis will run away and fault. Our control uses the counts from the sensor and motor when reading position. If either one of these signals is not working, our system will fault.

1. SM only – The first thing that can be done to see if it is the sensor is to turn off the sensor on the axis in question. This will allow the system to run only on the motor encoders. If the fault continues then the sensor was not the problem. Turn the sensor back on. See the Service Code Section for codes needed to turn the sensors on and off.
2. The next thing to do is to visually inspect the sensor and base to determine if there has been a crash. A damaged base will usually have crinkles in the small, triangular plates on the front and back.
3. Next make sure the sensor is preloaded correctly against the running surface. There is a setscrew on the base that allows for adjustment.
4. If no outward signs of damage are present, remove the sensor from its base, and inspect the wheel for damage and wear.

Look for chip contamination in gauge wheel and damage to running surface.

If the wheel is worn smooth in the center, replace the sensor.

Note: Sensors should not wear smooth for many years of normal operation.

5. If the sensor looks normal, it is probably OK and there is a mechanical obstruction somewhere in the set-up. Look for the following possible problems:
 - Broken or loose sensor base
 - Broken or loose bracket
 - Sensor tilted too much (so that the wheel is not engaging the running surface)

4.7.2 Measurements Do Not Repeat

1. Determine if the error in repeatability is random or accumulating:
 - Mount a dial indicator in the quill
 - Touch off a fixed point on the table and set the DRO to 0.
 - Traverse away approximately 6 inches
 - Return and touch off again
 - Write down the reading on the DRO.
 - Do not re-zero the DRO, traverse away and return several times
 - Write down the DRO readings

Random error will be unpredictable and give scattered readings, adding and/or subtracting the error after each traverse with no pattern. See Step 2.

Accumulating error will add roughly the same amount to the reading after each traverse. See Step 3.

2. For random error, look for problems in the set-up of the TRAK Sensor that have resulted in a loss of rigidity. Machines that have TRAK Sensors are TRM, DPM, & DPM5 (optional on DPMS3, DPMS5, Sport B3 & Sport B5).

Common sources of random error include:

- broken base
 - broken bracket
 - loose puller screws
 - loose run bar
 - very loose motion of the table or saddle
 - loose clamp screw
3. Accumulating error is almost always the result of the wheel not traveling in a path parallel to the motion of the axis. This causes the wheel to skip at certain regular points in its travel.
 - Inspect the base to determine if it has been damaged. A damaged base will usually have crinkles in the small, triangle-shaped plates on the front and back.
 - Use a bubble level or an indicator to adjust the puller screws so that the base is parallel to the running surface.
 - Inspect that the sensor is not cocked so that the case contacts the running surface.
 - Inspect the wheel for chips that are adhered or for gouges.

4.8 Electrical

4.8.1 Checking A/C Voltage

This procedure tests for the 115V power for the control.

- Use a Voltmeter, reading A/C volts.
- Acceptable range is 100V to 130V.

Note: systems running consistently close to the low values may have problems when normal voltage fluctuations push the voltage out of the acceptable range.

Test the following in the order presented:

Problems Here:	May Indicate:
1. The wall outlet.	<ul style="list-style-type: none">• Fuse blown in the shop electrical panel.• Incoming service from local utility is bad. Call the electric company.
2. The control power cord from the wall. Check the end that goes to the electrics box.	<ul style="list-style-type: none">• Power cord defective.
3. Check the top fuse on the electrical cabinet. It should be an 8-amp fuse.	<ul style="list-style-type: none">• If this is blown then power will not reach the 4 outlets on the electrical box – SM and M only.
4. Check the 110 power cord to the pendant.	<ul style="list-style-type: none">• Power cord defective

4.8.2 Checking Fuses

To check all fuses:

1. Use a Volt/Ohmmeter; select "OHM".
2. Remove the fuse completely from the pendant, electrics box or cable breakout box.
3. Place a lead of the meter on each end of the fuse.
 - A good fuse reads 0 (zero) or close to it.
 - A bad fuse reads Open or Infinity.

4.8.3 Cable Breakout Box Connections - Sport, DPMS3 & DPMS5 only

This module is located on the backside of the machine. It consists of 3 motor connections, 3 limit switch connections, 3 encoder connections and an E-stop connection.

Machines with an auxiliary function option have 2 more outlets. A 110 V outlet for a coolant pump or air solenoid and an indexer outlet.

The coolant pump signal and indexer signal comes down from umbilical #2.

4.8.4 Cable Connections

The milling machines use several cables to communicate between systems. What appears to be the failure of an electrical component might be due to a poor connection.

Indications:

- Control problems, chronic or intermittent.
- Motor problems
- Measurement problems

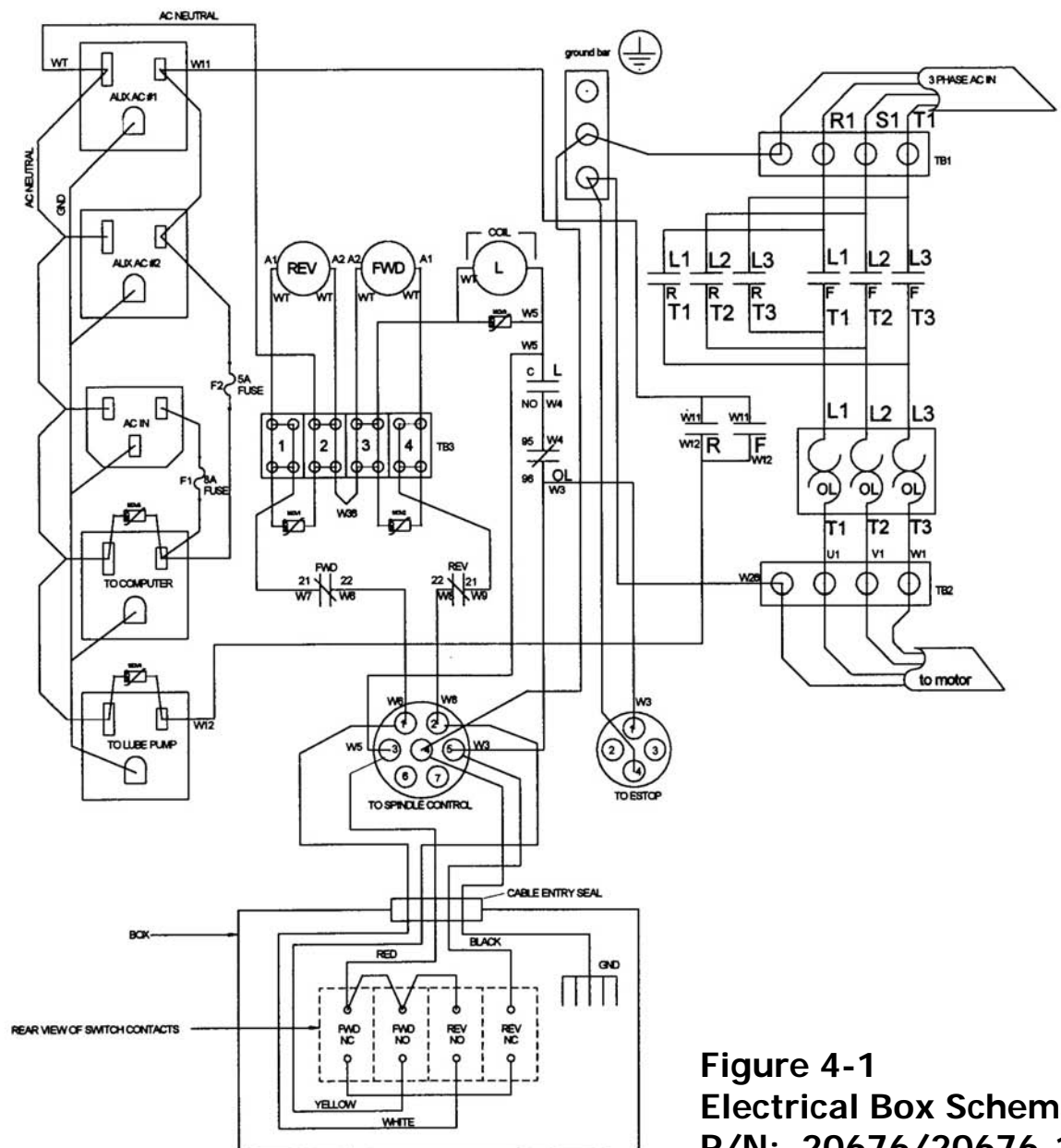
Explanation:

1. Turn off and unplug the system from the wall.

WARNING!

Do not plug and unplug connectors with the system power on. This may cause damage to the connector board and harm to the technician.

2. Visually inspect the connections for excessive debris, moisture, or obvious damage.
3. Carefully clean any chips away from the connectors.
4. One-by-one, take out each connector and then plug them back in. Do the same at the computer/display.
5. Make sure to tighten up the screws on each of the connectors.



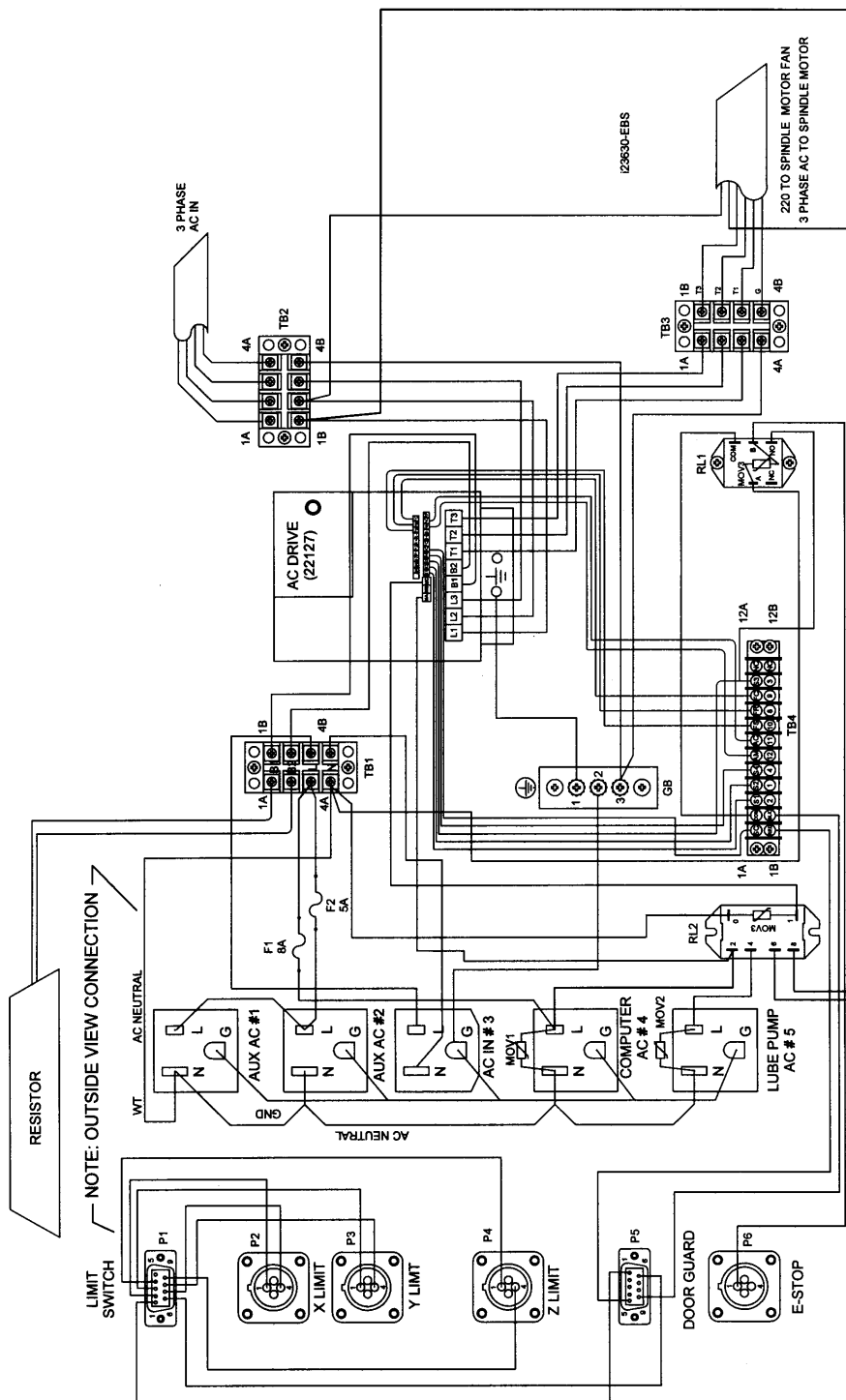


Figure 4-2 – Electrical Box Schematic – DPME2

4.9 External Connector Box – Sport B3 & B5

Indications:

- Control problems, chronic or intermittent.
- Motor problems
- measurement problems

Explanation:

It is often the case that what appears to be the failure of an electrical component is actually attributable to a poor connection.

1. Turn off and unplug the system from the wall.

CAUTION!

Do not plug and unplug connectors with the system power on. This may cause damage to the connector board.

2. Visually inspect the connections for excessive debris, moisture, or obvious damage.
3. Carefully clean any chips away from the connectors.
4. One-by-one, take out each connector and then plug them back in. Do the same at the computer/display. If the connection is sloppy, squeeze the connectors together to make a better connection.
5. Assure that the ground strap runs from the computer/display to the External connector box.

The External connector box must be protected from excessive debris or moisture.

4.10 Red LED Diagnostic Status Indicators – DPM/DPM5 (Sport B3/B5 with special electrics option)

There are 12 red LED diagnostic status indicators located on the right side of the relay module.

The meaning of these LED's is as follows (LED 1 is on the top):

1. LED 1 is on when the pendant is switched on. LED 1 also indicates that the computer module is receiving 115 VAC.
2. LED 2 is on when the E-Stop on the switch box is in the *Out* position and the overload relay has not been tripped. LED 2 is on during normal operation.
3. LED 3 is on when the switch box is receiving 115 VAC. LED 3 is on during normal operation.
4. LED 4 is on when the spindle switch on the switch box is in the 1 or 2 position and the spindle is on.
5. LED 5 is on when the coolant pump is on. The coolant pump can be turned on either by the switch box or via a CNC auxiliary function.
6. LED 6 is on when the overload relay is tripped. LED 6 is off during normal operation.
7. LED 7 is on when the E-Stop on the switch box is in the *Out* position. LED 7 is on during normal operation.
8. LED 8 flashes on when the Haas rotary table is being indexed one cycle or step. The function is controlled through Auxiliary Function 3.
9. LED 9 flashes on when the Haas rotary table has completed indexing one cycle or step.
10. LED 10 is on when Auxiliary Function 1 (coolant pump) is on.

11. LED 11 is on when Auxiliary Function 2 (air relay) is on.
12. LED 12 is on when Auxiliary function (spindle morot) is on.

4.11 Service Codes

All Service Codes are accessed in the SET-UP mode by pressing the "SERV CODES" softkey. For the EDGE control, SET-UP is accessed through the DRO mode. To access a service code, press the CODE # softkey, enter the number you want, and press INC SET. Follow the prompts on your monitor.

Note: If you are working with the SWI Customer Service Group, write the values down for Code 33 or Code 313. These values will be valuable for troubleshooting.

The following table depicts a brief description of all service codes used on the bed mills.

SERVICE CODE	MX2	AGE2	MX3	M3	AGE3	EDGE	SM	DESCRIPTION
11	X	X	X	X	X		X	Backlash Hysterisis Test (only with X & Y Sensors or Glass Scales)
12	X	X	X	X	X	X	X	Determines Feed Forward Constant
13	X	X	X	X	X	X		Sets Default Feed Forward Constant
14	X	X						Enters Program Scale Factor (0.1 to 10.)
22	X	X	X	X	X	X		Simulation Mode
33	X	X	X	X	X	X	X	Software Identification
34			X	X	X			Variable/Fixed Depth Drill Pecking
36			X	X	X			Fast/Slow Pecking
37			X	X	X		X	Selects DNC Baud Rate
38			X	X	X			Toggles on/off hard disk / zip drive
54	X	X	X	X	X	X	X	Continuous Run Mode
66	X	X	X	X	X	X	X	Metric Default; Bytes of ram for CNC2
67	X	X	X	X	X	X	X	English Default
68	X	X	X	X	X	X		0.01 mm (.0005") Display
69	X	X	X	X	X	X		0.01 mm (.001")
70	X	X	X	X	X	X		0.005 mm (0.0001")
79	X	X	X	X	X	X	X	Turns on Beeper
80	X	X	X	X	X	X	X	Turns off Beeper
81						X	X	Keyboard Test
89	X	X	X	X	X	X		Out of Simulation Mode
97	X	X	X	X	X	X		Axis Configurationn (dual feedback only)
98						X		Sets Default Configuration
99	X	X	X	X	X	X		Master Reset and Clear Program Memory
100	X	X	X	X	X	X	X	Axis Open Loop Test
101	X	X	X	X	X			X-Axis Motor Encoder Test
102	X	X	X	X	X			Y-Axis Motor Encoder Test
103			X	X	X			Z-Axis Motor Encoder Test
123	X	X	X	X	X	X	X	Sensor Calibration Mode – See Section 5.2.2 for details
124			X		X			Z-Axis Encoder Calibration

SERVICE CODE	MX2	AGE2	MX3	M3	AGE3	EDGE	SM	DESCRIPTION
125	X	X	X	X	X	X		Displays Calibration Factors
127	X			X		X	X	Single Encoder Axis Backlash Calibration – See Section 5.2.2 for details
128	X			X		X	X	Enters Single Encoder Axis Backlash Calibration Constant
129		X		X	X	X	X	Enters Arc Accuracy
131							X	Manual DRO, Disables Electronic Handwheels
140	X	X	X	X	X			Irregular Pocket Stepper Distance Adjustments
141		X	X	X	X	X	X	Restores EEPROM From System Disk
142		X	X	X	X	X	X	Saves EEPROM to System Disk
160						X		Brightness control
200			X	X	X			Auxiliary Function Test
201			X	X	X	X		Displays error codes
202			X	X	X			Enables/Disables Z Jog
304							X	Toggles X Sensor or Glass Scale On/Off
305							X	Toggles Y Sensor or Glass Scale On/Off
312							X	Toggles Limit Switch On/Off
313							X	Displays Configuration
314							X	Toggles Test Lights 'On' in Status Line
316							X	Updates Master Software
317							X	Updates Slave Software
318							X	Activates Converters or Options
319							X	Error Log - Captures All Commands Sent to Servo System
321							X	Reverses Y Position Sensor Direction
322							X	Reverses X Position Sensor Direction
323							X	Switches between COM ports for RS232 applications
324							X	Toggles Simulation Mode
325							X	Reverses Quill Sensor Direction
326							X	Error Message Display
327							X	Memory Status
335							X	Toggles Spindle On/Off During Pause Events
336							X	Enables Spindle to Stay On throughout All Modes
818	X	X	X	X	X			Displays available memory

4.11.1 CODE 11: Hysteresis

Note: This code is use only for systems with Sensors or Glass Scales on the table and saddle.

Code 11 service routine checks the readings of the motor encoder against the sensor encoder. It is a measurement of how much motor motion is necessary to create table or saddle motion. This test helps us to look at two things:

- Play: How much backlash must be taken up when motion is reversed.
- Friction: How much the mechanical components must be "torqued up" in order to break the friction and create motion.

The Code 11 procedure is very useful and will help in diagnosing all types of motion and performance problems.

1. Position the table and saddle in the center of travel. *Note: You will lose your DRO position reference.*
2. Go into the Service Codes and input Code 11.
3. The system will run the checking routine automatically and then display the values in the position readout.

Explanation:

As an overall measure of the system hysteresis, we are looking for the X and Y values to be less than .004". A value greater than this indicates a problem with either excessive friction or play that may affect the finish or accuracy of machined parts.

4.11.2 CODE 12: Feed Forward Constant

The Code 12 procedure helps the control "learn" the friction characteristics of the machine by sending a graduated series of motor signals and observing the results. The process takes less than 30 seconds to run. It is both a diagnostic routine that displays values, and a routine that sets the parameters of the control for the particular machine.

The Code 12 is used for diagnosing and resolving:

- Problems with machine motion.
- Machined parts come out bad – especially poor finish.

Note: Code 12 routine will set the parameters for the particular machine and its particular situation. If the machine changes its friction characteristic, the Feed Forward Constant should change too, or the system will not servo properly. Whenever gibs are adjusted or a heavy workpiece has been added to the table, you should run Code 12. When the heavy workpiece is removed, run Code 12 again.

1. Position the table and addle in the center of travel. *Note: You will lose your DRO position reference.*
2. Go into the Service Codes and input the Code 12.
3. For SM control, press Auto
4. The system will run the routine automatically and then display values on the position readout.

Explanation:

Typical values should be between 4.04 and 11.11 are considered normal for each axis. Higher values indicate excessive friction in the system. Lower values indicate a loose system and may mean a gib adjustment is necessary. Value 4.04 means the friction is a factor of 4 in one direction, and 4 in the other direction. The values should be within 3 or 4 of each other in both directions. A value of 6.08 would still be considered normal.

On Sport products, do not equate Code 12 values to torque on ball screw. Measure friction in system with an in-lb torque wrench.

SM and EDGE only -- The feed forward gain can be adjusted manually by pressing the manual button. Choose the axis you would like to change and then enter values in the positive and negative direction to adjust. Adjusting the gain can help solve circularity problems. Default values can be set by pressing the Reset button. The manual feature should only be used in extreme cases where the AUTO routine did not solve the problem. Manual adjusts above 12 may lead to servo related problems.

4.11.3 CODE 33: Software ID**4.11.3.1 EDGE & SM Controls**

Code 33 is the software identification procedure. The two types of software in the control include:

- **Software Version** - the version of the system you have installed
- **Firmware Version** - the version of firmware software that is responsible for control to servo interface.

4.11.3.2 MX, AGE and M3 Controls

The code 33 is the software identification procedure. The two types of software in the control include:

- **Floppy** - the version of the system you have installed
- **Slave** - the version of EPROM software that is responsible for control to servo interface.

Steps:

1. Go into the Service Codes and input the Code 33.
2. If you are working with the SWI Customer Service Group, write the values down.

Note: Remember that there are two floppy disk drives. The bottom disk drive is for the system disk.

4.11.4 CODE 97: System Axis Configuration

This procedure sets the Plus and Minus motion for the Motor encoders. It is often necessary to perform this procedure after a new installation or after installing a new Computer/Pendant.

Steps:

1. Center the table and saddle and position the quill about halfway down.
2. Go into Service Codes and input Code 97.
3. Very carefully, move the table, the saddle and the quill in the positive direction, less than 6 inches for each axis. Positive motion is:
 - X - table moves to the left (so the tool moves to the right relative to the workpiece). + = CW

- Y - saddle moves toward the front (so the tool moves up relative to the workpiece). + = CCW
- Z - the quill moves up, the ram moves up. The ram and quill must both be moved in the positive direction. To move the ram, turn the ball screw manually.

If you do not move correctly from the beginning, repeat the procedure.

4. Press INC SET to signal the procedure is complete.

4.11.5 CODE 100: Axis Open Loop Test

Code 100 procedure is used to diagnose problems with the configuration of the system, the encoders and incoming A/C voltage.

IMPORTANT -- SAFETY NOTICE

During this procedure the designated axis will be given a command to move at maximum speed for 1 second in the direction you choose. Avoid crashes by making sure the quill is out of the way and by starting with the table and saddle centered. **MAKE SURE THAT NO ONE IS STANDING IN THE WAY OF THE TABLE OR SADDLE!**

Note: You will lose the DRO reference position.

This procedure is to be run for each axis that is servo-driven and for both the plus and minus direction for each axis. The following 6 steps apply to all controls. Refer to Sections 4.11.5.1 through 4.11.5.3 for specific control display data and interpretation.

1. Center the table and saddle and raise the head. Make sure the gib locks are released.
2. On the Pendant display, go into the Service Codes and input the Code 100.
3. The conversation line will say: "SELECT AXIS". Input the axis. Either X, Y or Z.
4. In the conversation line it will say "WHICH DIRECTION? PLUS".
 - If you want to run in the plus direction, press INC SET.
 - If you want to run in the minus direction, press +/-, then INC SET
5. In the conversation line it will say "PRESS GO". Press Go after you are sure that the machine will not crash in the direction and axis that you have specified.
6. Afterward the screen will display values next to the DRO position axes. The table below assumes machine has secondary feedback. Machines with motor encoders only will display the reading next to the axis in question.

4.11.5.1 All controls with dual feedback – sensors or glass scale.

Your input	Display	Data displayed.
X +	X	table encoder reading
	Y	nothing (should be 0)
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained

Your input X -	X	table encoder reading
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained.
Your input Y +	X	nothing (should be 0)
	Y	table encoder reading
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained
Your input Y -	X	nothing (should be 0)
	Y	table encoder reading
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained
Your input Z +	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained
Your input Z -	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained

Interpretation of the resulting values displayed:

The values for the encoder displays should be in the range of 3.0000" to 5.0000".

- If the motor encoder and sensor or glass scale reading is not within this value, then the one that is out of specification may be the problem. If one of the encoders is not reading then it will need to be replaced.
- The feedrate should be a minimum of 120 ipm for X and Y-axis, and 180 ipm for Z. The DPMS3 and DPMS5 should be a minimum of 180 ipm on the X, Y, and Z axes.
- If the feedrate is less than 180 ipm and inconsistent in both directions, check the incoming AC voltage and mechanics of the drive train.

4.11.5.2 EDGE Control , SM control, and M control – without feedback.

Your input X +	Display	Data displayed.
	X	motor encoder reading
	Y	nothing (should be 0)
	Z	nothing (should be 0)
Your input X -	Feedrate	the maximum feedrate attained
	X	motor encoder reading
	Y	nothing (should be 0)
	Z	nothing (should be 0)
Your input Y +	Feedrate	the maximum feedrate attained
	X	nothing (should be 0)
	Y	motor encoder reading
	Z	nothing (should be 0)
Your input Y -	Feedrate	the maximum feedrate attained
	X	nothing (should be 0)
	Y	motor encoder reading
	Z	nothing (should be 0)

Your input Y -	X	nothing (should be 0)
	Y	motor encoder reading
	Z	nothing (should be 0)
	Feedrate	the maximum feedrate attained

Your input Z +	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained
Your input Z -	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained

Interpretation of the resulting values displayed:

The values for the encoder displays should be in the range of 3.0000" to 5.0000".

- If the motor encoder reading is not within this value, then the one that is out of specification may be the problem. If one of the encoders has no output then the motor assembly will need to be replaced.
- The feedrate should be a minimum of 120 ipm for X and Y-axis, and 180 ipm for Z. The DPMS3 and DPMS5 should be a minimum of 180 ipm on the X, Y, and Z axes.
- If the feedrate is inconsistent in both directions, check the incoming AC voltage and mechanics of the drive train.

4.11.6 CODE 101: X-Axis Motor Encoder Test

A manual diagnostic routine to compare the motor and position encoders. Used only on machine with glass scales.

Steps:

1. Go into Service Codes and input 101.
2. Crank the X-axis fast for two inches, then reverse direction and position the X so that the readout is 1.000".
3. Read the resulting values from the position readout. The chart above (Code 100) shows the data this is displayed.

The values for the motor encoder and the position encoder should be very close to each other, within 5% or so. They should also have the same +/- value.

- If they have different values, i.e., + for one and - for the other, perform Service Code 97.
- If the motor encoder and position encoder is not within 5% of each other, recalibrate the system. If the problem persists, the motor encoder is suspected. Note: If the motor encoder is bad, it will be necessary to replace the entire motor.

4.11.7 CODE 102: Y-Axis Motor Encoder Test

Manually move the saddle handwheel. See Code 100 above.

4.11.8 CODE 103: Z-Axis Motor Encoder Test

Manually move the quill and ball screw. See Code 100 chart above for displayed values.

4.11.9 CODE 123: Calibration

See Section 5.2.2 for a further explanation of this code.

4.11.10 CODE 127 - Set X or Y Backlash Constant

See Section 5.22 for a further explanation of this code.

4.11.11 CODE 128: Input Backlash Constant

Code 128 allows you to enter the feedback controllers backlash values for each axis. It displays the value after it enters. This code is used on machines with motor encoders only, no secondary feedback encoders.

4.11.12 Code 129: Arc Accuracy

When the control operates at high feedrates, it may create small part machining errors as it goes around sharp corners. This exists on all CNCs and is commonly called a "following error." The control is factory preset to allow a maximum following error of 0.001 inch. The feedrate will automatically be adjusted around sharp corners so as to not violate this limit. This code only applies to arcs that are programmed and ones that are created in the tool path to generate the shape you want. This code will not make a difference on mill moves.

You may adjust the maximum following error to a value as small as .0001 inch. However, the smaller the value, the slower the feedrate around corners.

To input a new Following Error use the following procedure:

Follow the instructions on the screen and input the Following Error value (from .0001 to .0100) and press **INC SET**.

4.11.13 Code 314: Toggle Test Lights 'On' in Status Line SM only

This code toggles on and off 2 test lights that appear in status line. The top light signifies if the master software is working. If functioning it should flash a green light. The bottom light signifies if the slave firmware is functioning. It will appear orange in run mode when it is processing information. Pressing the mode key will change this orange box to black. The orange box will also change to black when the program you are running reaches the 3rd event from the end of the program. If the firmware is locked up no keys will work. This code is useful for diagnosing intermittent problems with the control locking up.

Turn the X, Y, or Z-axis electronic hand wheel. The display should show movement as the hand wheel is being turned. There should be no skipping and it should count smoothly while the hand wheel is being turned. One revolution of hand wheel should read 0.2000".

4.11.14 Code 319: Error Log – SM only

This code when turned on captures the commands that were sent to the servo system. It includes items such as positioning commands, errors, stop and go commands, etc. It

may be helpful for identifying problems between programmed commands and executed commands. To turn on the error log press the F6 softkey. The page forward and backward keys allow you to scroll through the file one page at a time. The data forward and data backward keys allow you to scroll through the file one line at a time. The data bottom key takes you to the bottom of the file and then changes to data top which will take you back to the top. The file will capture data until the file reaches a size of approximately 600 KB. At this time the file is saved to a backup file and the original file is cleared and data is once again captured. Once again as the file reaches a size of 600 KB it copies over the previous backup file. From here the user can save the file to the floppy drive by pressing the F8 softkey. Once this is done it prompts you for which file you want to save to disk. The F1 key saves the current file to disk and the F2 key saves the backup file to disk. To clear the files press the F7 softkey.

5.0 Procedures for Replacements & Maintenance

5.1 Replacements

5.1.1 Servo Motor Replacement

WARNING!

Do not work with the Servo Motors unless the power is disconnected from the machine. The servomotors are run by 110 VAC. There is possibility of death by electrocution!

1. Turn off power to the machine.
2. Each motor is mounted by the use of (4) ¼-20 screws. Be careful not to over-tighten these bolts and strip the threads.

5.1.2 Servo Driver Replacement

WARNING!

Do not work with the Servo Drivers unless the power is disconnected from the machine. The servo drivers are run by 110 VAC. There is possibility of death by electrocution!

The Servo Driver for each axis is integrated into the servo motor casting.

DANGER!

Always engage (push in) the Emergency Stop switch, turn the ProtoTRAK SM Control off, and disconnect the servo motor/driver cable at the cable breakout box.

1. Press in the Emergency Stop (E-Stop).
2. Remove the servo motor/driver assembly from its mounting bracket (the Y axis assembly is located inside the front of the bed).
3. Remove the 10 cap screws that hold the servo driver and its heat sink plate to the motor casting.
4. Disconnect the cable connector. Do not pull on the wires.
5. Reinstall the new servo driver with its heat sink plate. Be certain the gasket properly seals the assembly.
6. Reinstall the motor/driver assembly. Make certain the belt is tight so that there is little play if pinched in the middle.

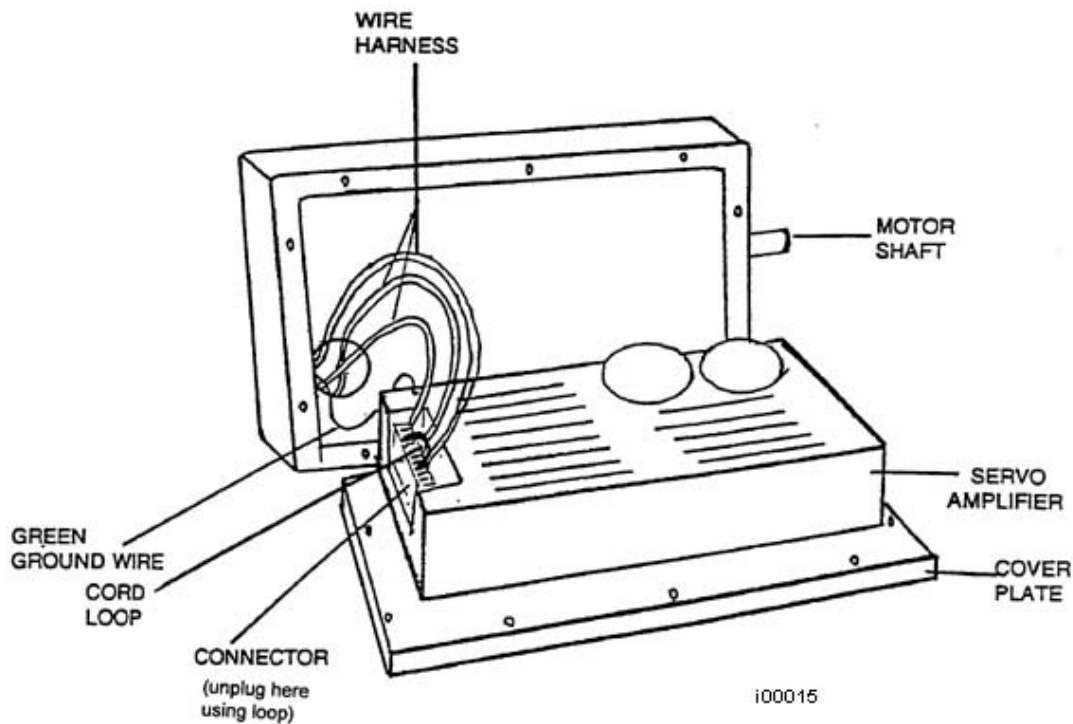


Figure 5-1
Servo Driver Replacement

Part #	Description
20327-2	Z Servo Driver
20201	X & Y Servo Driver

5.1.3 Computer Module Replacement

5.1.3.1 Edge 3 Computer Module Replacement

1. Turn off power to the machine and control.
2. Unplug all the connectors on the pendant arm side of the pendant.
3. Remove 2 screws on the right side of the unit and 2 screws on the backside of the unit. The module is now free to slide toward the right side of the pendant.
4. Slide the computer module a few inches and stop. Pulling the computer module too far will damage the LCD cable.
5. Now reach from the pendant arm side of the unit and disconnect 3 ribbon cables from the module.
6. Follow the instructions in reverse order when reinstalling the new computer module.
7. Make sure the connectors are fully seated before bolting the unit back in place.

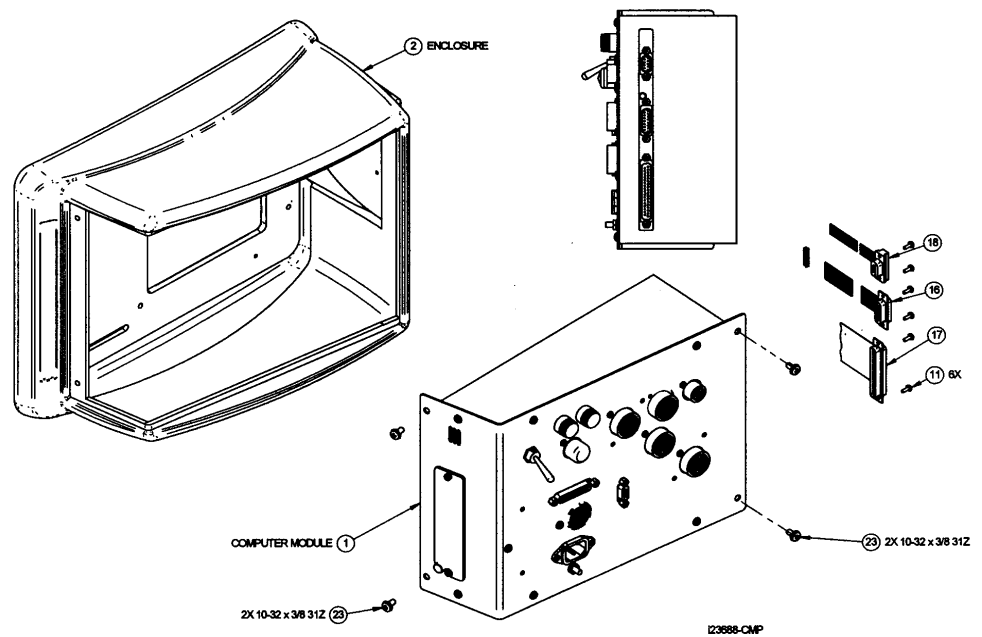


Figure 5-2
Computer Module Replacement – EDGE

5.1.3.2 AGE and MX Computer Module Replacement

The computer module is a black box located inside the computer cabinet, mounted on the back of the column.

DANGER!

Always unplug power at the back of the display pendant and press in (engage) the Emergency Stop (E-Stop) before opening the computer cabinet.

1. Turn off power.
2. Unplug the four AC plugs on the bottom of the enclosure.
3. Disconnect the two ribbon cables and ground wire.
4. Unscrew the two silver Philips head screws. The entire module can now slide out of the cabinet.
5. Sensors and Z ball screw must be recalibrated when the computer module is replaced.
6. Z backlash must be re-inputted when the computer module is replaced.

5.1.3.3 SM3 Computer Module Replacement

1. Turn off power to the machine and control.
2. Unplug all the connectors on the pendant arm side of the pendant.
3. Remove 4 screws on the right side of the unit and 2 screws on the left side of the unit. The module is now free to slide toward the right side of the pendant.
4. Slide the computer module a few inches and stop. Pulling the computer module too far will damage the LCD cable.
5. Now reach from the pendant arm side of the unit inside and remove the 37-pin LCD cable.
6. Now slide the module about ½ way out of the pendant sheet metal.
7. Remove the ground stud from the side of the computer module.
8. Next remove the 37 and 9 pin connectors from the top of the computer module.
9. Lastly slide the unit completely out of the sheet metal.
10. Follow the instructions in reverse order when reinstalling the new computer module.
11. Make sure the connectors are fully seated before bolting the unit back in place.

Note: if the flash drive is functional, you may want to remove the flash disk and install it in the new flash drive

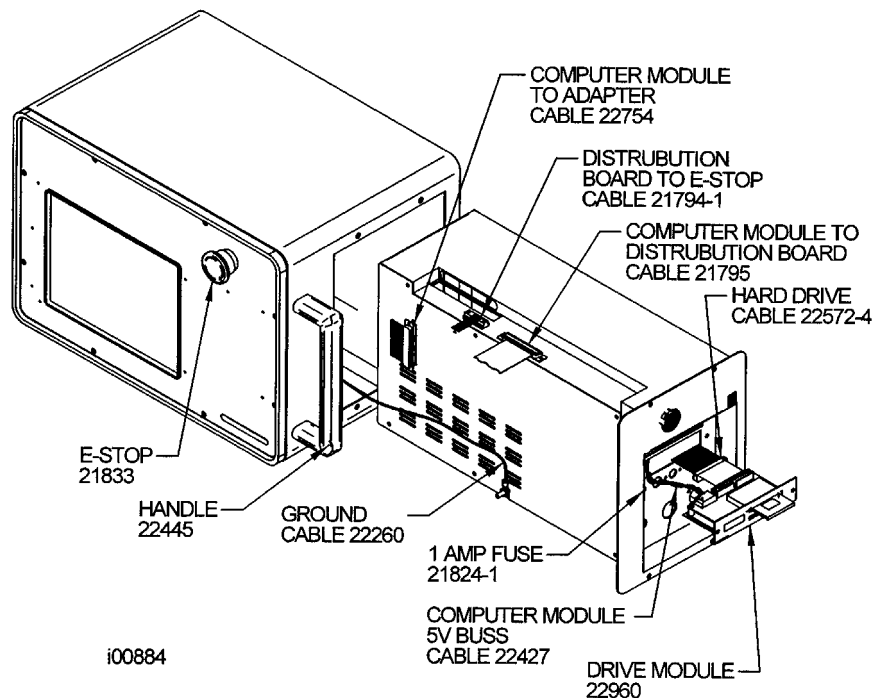


Figure 5-3
Computer Module & Flash Drive Replacement – SM3

5.1.4 System Flash Disk Replacement (SM3 only)

The system software for the SM control is contained on a 64 MB flash disk that is located under the door on the right side of the pendant in the upper flash drive slot. If this needs to be replaced, push the bottom to eject the disk and reload the new disk. Turn power off to the machine before doing this replacement.

CAUTION!

It is a good idea to back up your flash drive from time to time via a network or floppy disk. If your flash drive needs to be replaced you will lose all of your programs. See your programming manual for instruction on how to do this.

5.1.5 Cable Routing on Machine

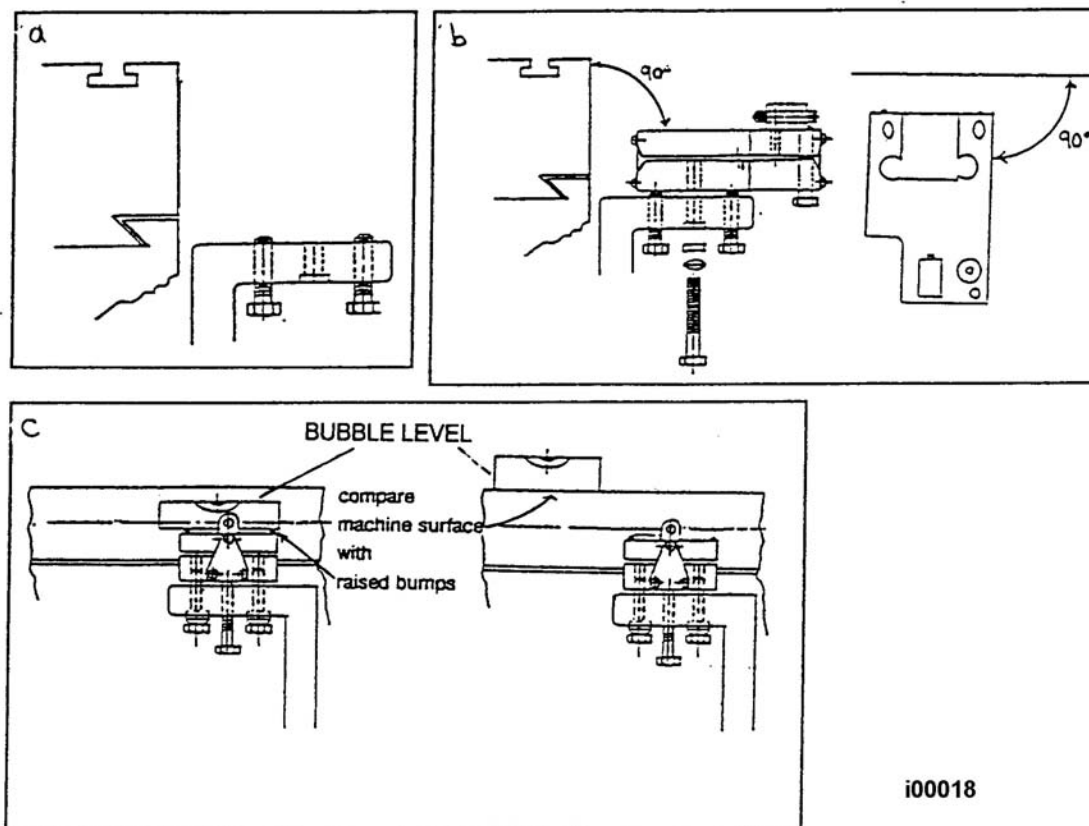
Whenever you replace a cable or reroute a cable it is very important to keep the power cables and logic cables separated from each other. The power cables consist of the (3) 110-volt motor cables and (2) 110-volt power cables for the pendant, and a coolant pump or solenoid power cable. The logic cables are used to carry encoder signals between the cable breakout box and computer module. Mixing of the power and logic cables may cause noise from the power cables to interrupt the signals in the logic cables. This can lead to intermittent axis faults or repeatability problems. See Figures 2-15 for a layout of the cable connections.

5.1.6 TRAK Sensor Replacement, where applicable

5.1.6.1 *Replacing the M5 Base*

See Figures 5-4 and 5-5

1. Remove the sensor by removing the clamp screw and then backing the load screw out a few turns. The sensor should lift off the base easily.
2. Remove the old M5 Base by removing the two 1/4-20 hex head screws that are threaded into the base.
3. Assemble the new base as per Figure 5-4.
4. Use a bubble level to align the raised bumps on the base with the table for X axis or saddle ways for Y-axis.
5. A dial indicator may be used to align the bumps on the base instead of a bubble level.



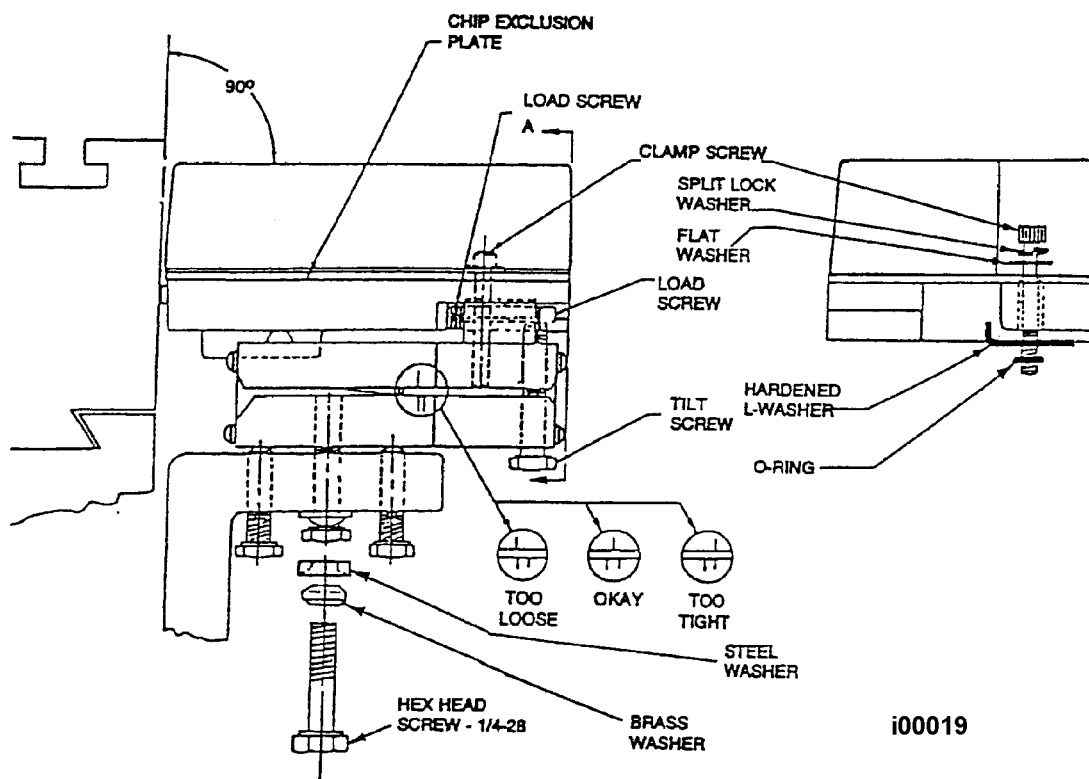
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Figure 5-4
M5 Base Mounting

5.1.6.2 Replacing the TRAK Sensor

1. Remove the old sensor by removing the clamp screw and then backing the load screw out a few turns. The sensor should lift off the base easily.
2. Install the new sensor on the M5 base using the clamp screw.
3. Load the sensor against the running surface (table or run bar) using the load screw. The white lines on the side of the M5 base tell you when it is loaded correctly.

Note: You want to load the gage wheel against the running surface using the flat spring of the M5 base. Do not tighten the clamp screw fully until after loading the sensor.



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Figure 5-5
TRAK Sensor Mounting

Parts List

Item	P/N	DESCRIPTION
1	M250C	SENSOR - ALL TRAK PRODUCTS
2	M5	M-5 BASE
3	LDCEL-C	LOADCELL - M250C
4	M5 HDWR	HARDWARE - M5 BASE
5	16023-1	BRACKET-SENSOR X-AXIS
6	21511	EXTENSION
7	24227	BAR-RUN Y-AXIS
8	13777-1	BRACKET-SENSOR Y-AXIS
9	13346-3PK	CHIP SCRAPER-M250C

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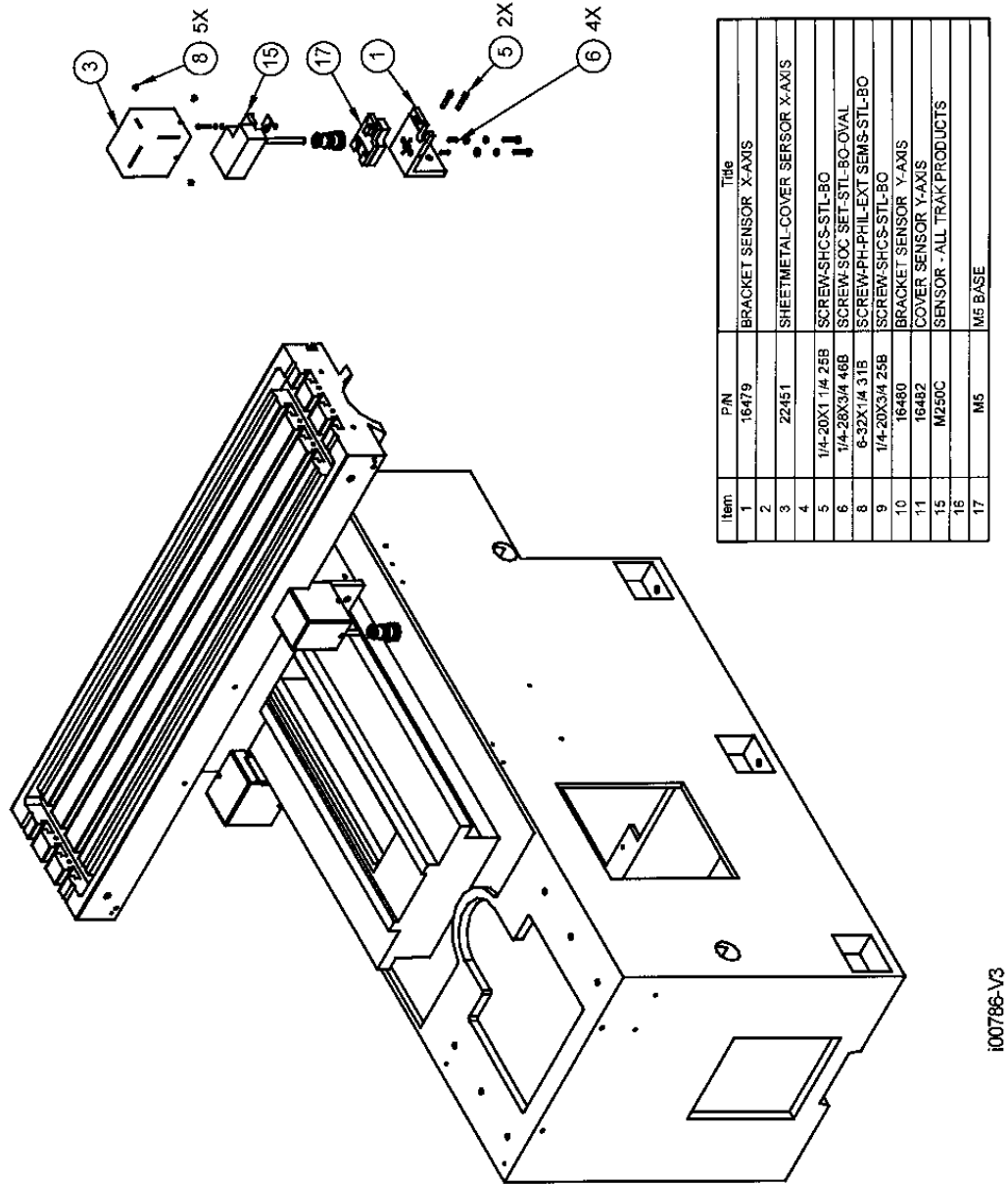
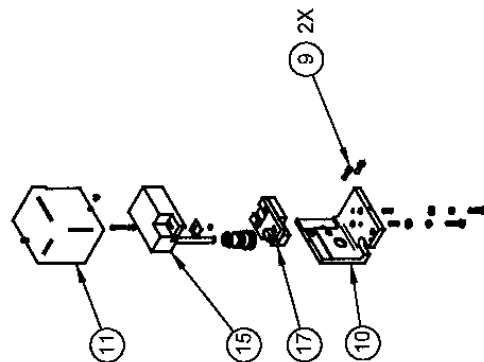
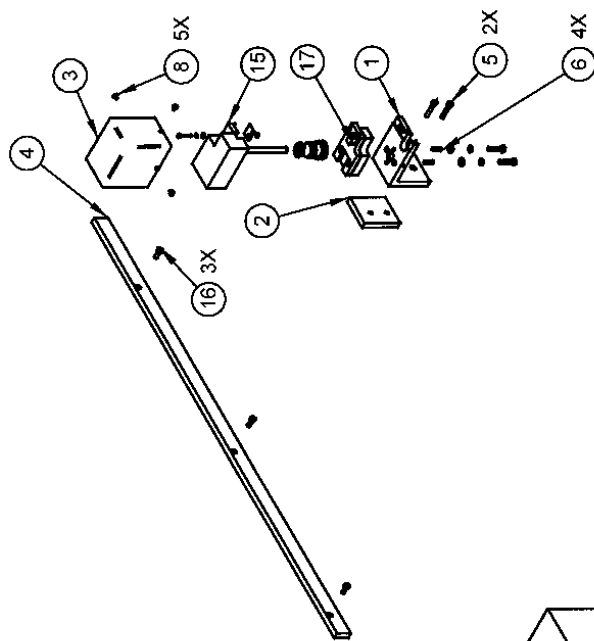


Figure 5-6
DPMS3 Sensor Assembly





Item	P/N	Title
1	16479	BRACKET SENSOR X-AXIS
2	22410	PLATE DPM5-SENSOR SPACER X-AXIS
3	22451	SHEET METAL COVER SENSOR X-AXIS
4	22409	RUNBAR-DPM5-SENSOR
5	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO
6	1/4-28X3/4 46B	SCREW-SOC SET-STL-BO-OVAL
8	6-32X1/4 31B	SCREW-PL-PL-EXT SEMS-STL-BO
9	1/4-20X3/4 25B	SCREW-SHCS-STL-BO
10	16480	BRACKET SENSOR Y-AXIS
11	16482	COVER SENSOR Y-AXIS
15	M250C	SENSOR - ALL TRAK PRODUCTS
16	1/4-20X5/8 25B	SCREW-SHCS-STL-BO
17	M5	M5 BASE

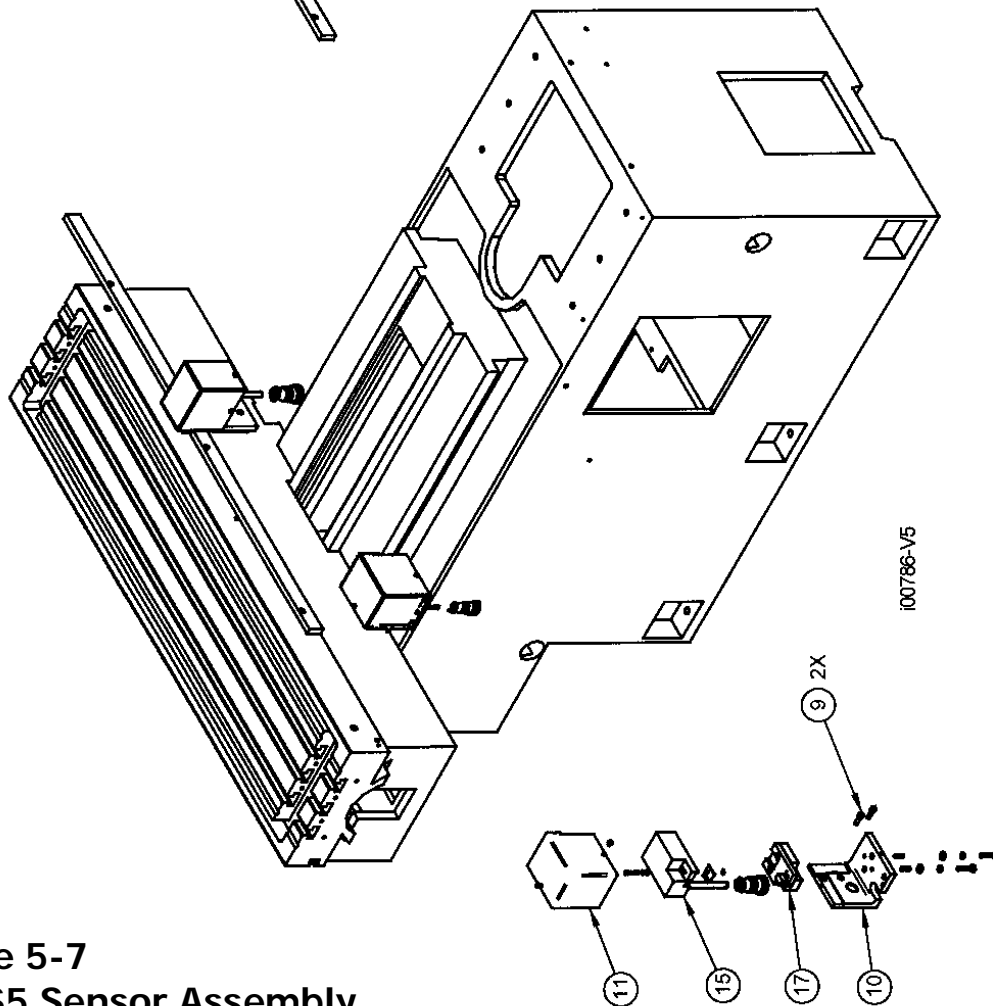


Figure 5-7
DPMS5 Sensor Assembly

5.1.7 Glass Scale Replacement

5.1.7.1 Remove the X, Y or Z Glass Scale, where applicable

1. Unplug the glass scale connector from the cable breakout box.
2. Unbolt the reader head of the glass scale from its mounting surface.
3. Unbolt the glass scale enclosure from the table on X or the mounting spar on Y.
4. Install the head alignment bracket that came with the replacement scale to this scale to secure it for shipping back to SWI. Failure to do this may cause the glass scale to get damaged during shipment. The head alignment bracket secures the reader head so it cannot move and damage the glass in the scale.

Note: 1st align the reader head on the new scale before removing it to fasten the old scale.

CAUTION!

Once the head alignment bracket is installed, do not traverse the axis or the reader head will break.

5.1.7.2 Install the X or Y Replacement Scale

CAUTION!

If the scale is not long enough for the table, it will break when the machine is traversed past the scale travel.

1. Mount the scale to the back of the table or Y-axis mounting spar.
2. Align the sale so that it is within +/- 0.005" end to end.
Notes: For the Y-axis, the mounting spar should already be aligned. It must be parallel to the Y-axis travel within +/- .005" end to end both horizontally and vertically. The mounting spar can be aligned in and out by the use of the adjustment screw.
3. Line the reader head up with the mounting holes on the back of the saddle for the X-axis or the bracket on the Y-axis.
4. Install the reader head bolts but leave them loose.
5. Use the jackscrews on the reader head to compensate for some gap between the reader head and the reader head mounting bracket. Leave the alignment brackets attached to the reader head. This bracket assures the reader head is aligned to the glass scale.
6. Tighten each jackscrew until it touches the bracket and then back it off 0.001" or 0.002". Use a feeler gage to set the gap.
7. Tightening the reader head mounting screws. This ensures the reader head is aligned within a few thousandths.
8. Remove the shipping bracket that fixes the reader head to the scale for shipping.

WARNING!

After the reader head is attached to the reader head mounting bracket, do not move the machine axis until the shipping bracket is removed. This will break the reader head. This is not covered under warranty.

See Figures 5-8 through 5-10 for an illustration of how to install glass scales.

5.1.7.3 *Install the Z-Axis Glass Scale, where applicable* (See Figure 5-8)

1. Check the tram of the head in the X direction. If it is within a few thousands then continue on. If not tram.
2. Assemble Z-axis glass scale mounting bracket and mount to head. Items 1, 2, 3 and 4. Tap items 3 and 4 together and tap item 3 into the quill stop knob. Leave the bolt loose. Use 2 screws (item 6) and mount item 4 to the side of item 2 using a spacer between both items to provide a gap of approximately 0.040" between Items 2 and 4. This is to make sure item 2 does not rub against item 4.
3. Align the glass scale bracket (Item 2) with an indicator and tighten the mounting screws. Leave the quill stop knob screws loose. Remove the spacer and bolts from Item 4.
4. Unscrew the shipping protection screw from the scale.
5. Mount the glass scale to the mounting bracket and align it with an indicator. It needs to be aligned within 0.008" with respect to the quill. Tighten the screws down.
6. Fasten the readerhead to the readerhead bracket.
7. Move the readerhead up and down the glass scale and make sure the gap is consistent between the readerhead and the glass scale. Tighten the screw to the quill stop knob.
8. Remove the red head securing plate.
9. If the gap is not consistent between the readerhead and the glass scale when moving the quill up and down then adjust the angle of the scale to make the gap consistent.

WARNING

The gap must be no larger than 0.060" between the readerhead and glass scale.

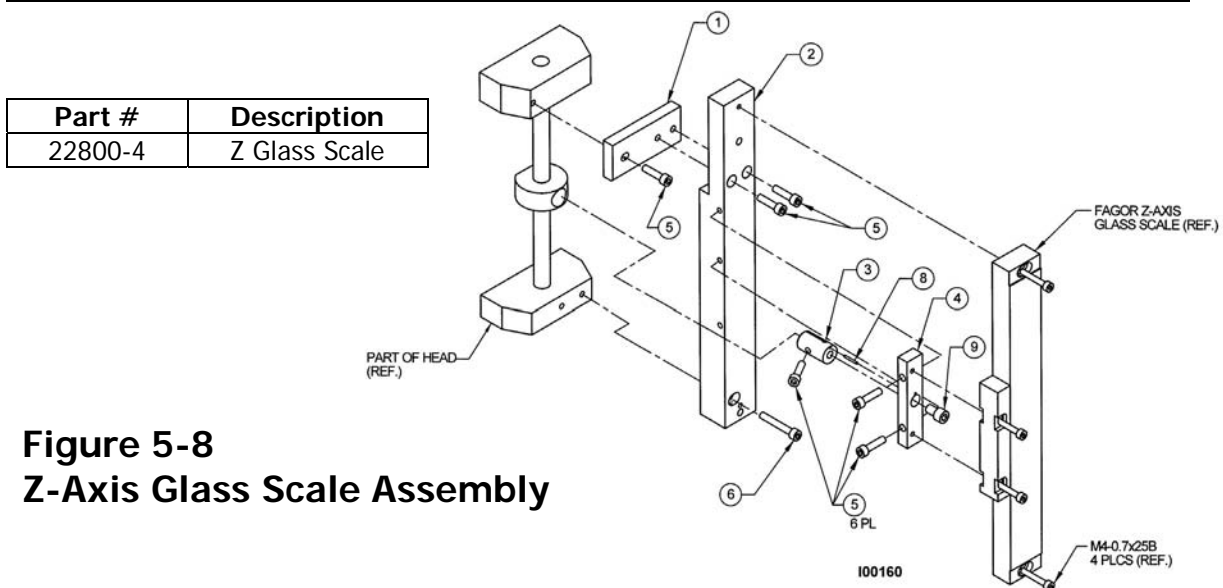


Figure 5-8
Z-Axis Glass Scale Assembly

Item	P/N	Description	Qty
1	20550	ARM- Z-AXIS MOUNTING PLATE	1
2	20551	MOUNTING PLATE-Z-AXIS GLASS SCALE	1
3	20548	ADAPTER-Z-AXIS GLASS SCALE	1
4	20549	ADAPTER PLATE- Z-AXIS GLASS SCALE	1
5	10-32X3/4 25B	SCREW-SHCS-STL-BO	4
6	10-32X1 1/4 25B	SCREW-SHCS-STL-BO	3
7	15759	WASHER-1/4 HARD BLK OX 1/8 THK	1
8	1/16X1/2 81B	SPRING PIN	1
9	1/4-28X3/8 25B	SCREW-SHCS-STL-BO	1
11	M4 70B	WASHER-FLAT USS-STL-BO	4
12	M4 75J	WASHER-EXT TOOTH-SS	4

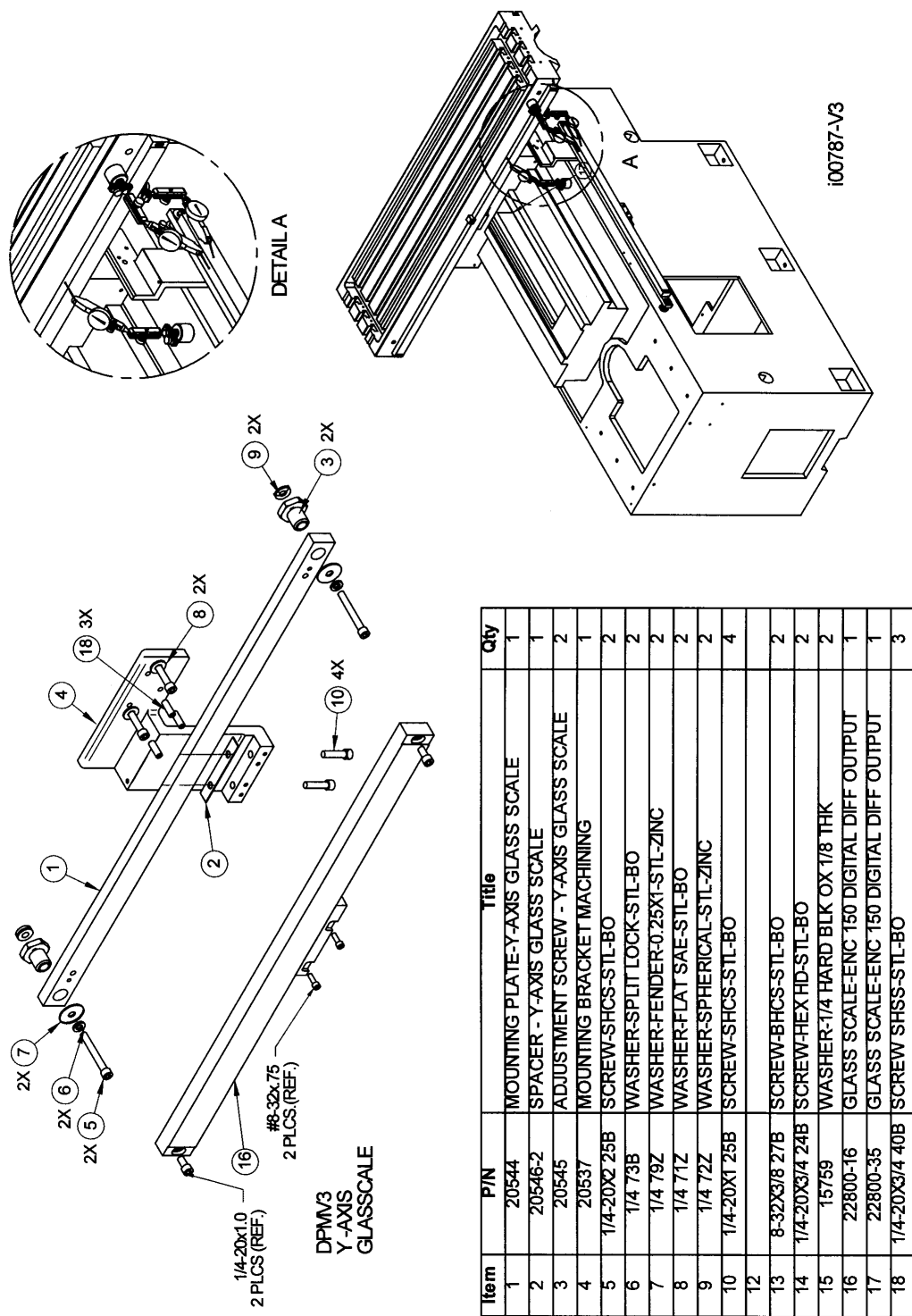
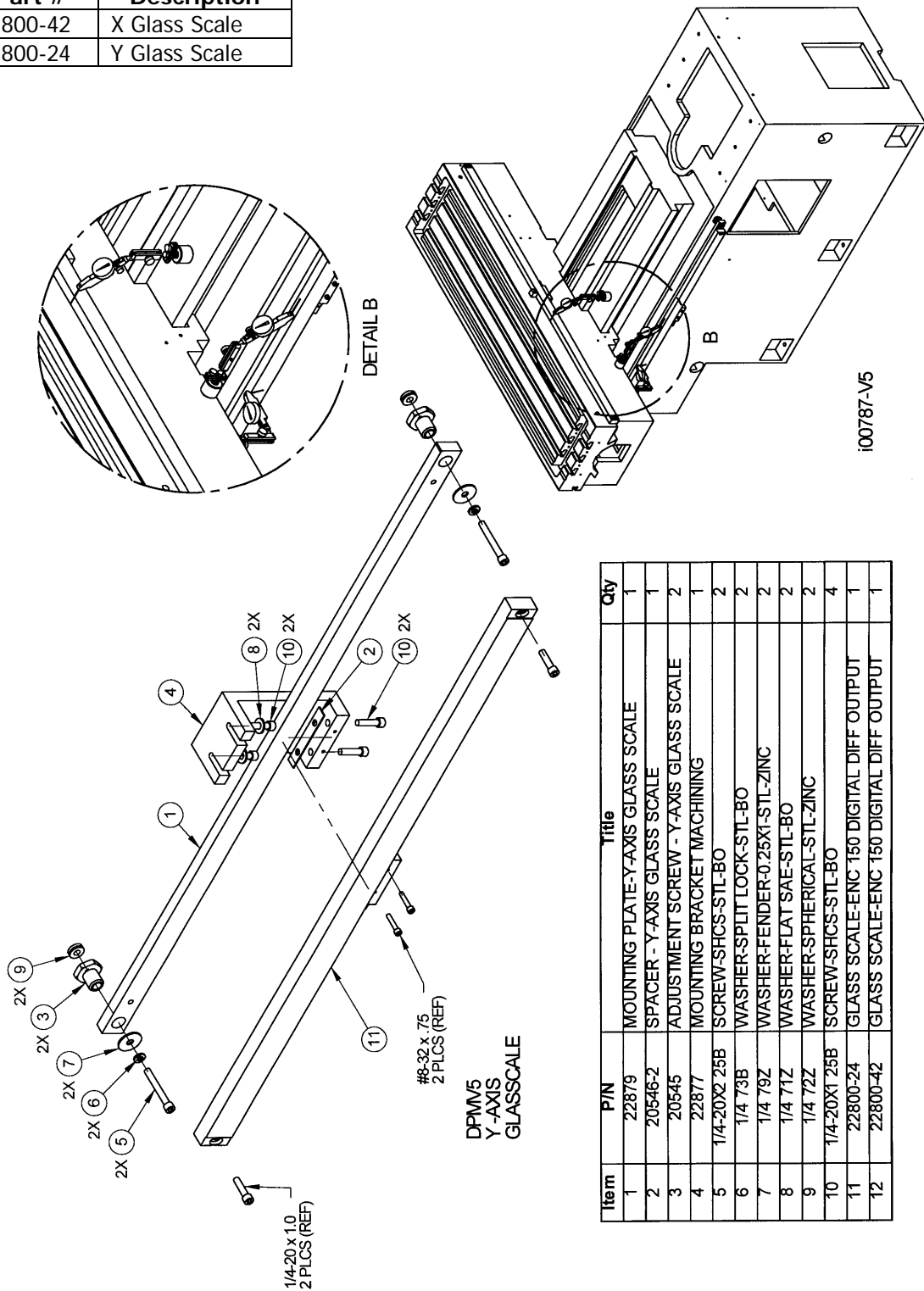


Figure 5-9
Glass Scale Alignment – TRM, DPM, Sport B3, DPMS3

Part #	Description
22800-42	X Glass Scale
22800-24	Y Glass Scale



Item	P/N	Title	Qty
1	22879	MOUNTING PLATE-Y-AXIS GLASS SCALE	1
2	20546-2	SPACER - Y-AXIS GLASS SCALE	1
3	20545	ADJUSTMENT SCREW - Y-AXIS GLASS SCALE	2
4	22877	MOUNTING BRACKET MACHINING	1
5	1/4-20X2 25B	SCREW-SHCS-STL-BO	2
6	1/4 73B	WASHER-SPLIT LOCK-STL-BO	2
7	1/4 79Z	WASHER-FENDER-0.25X1-STL-ZINC	2
8	1/4 71Z	WASHER-FLAT SAE-STL-BO	2
9	1/4 72Z	WASHER-SPHERICAL-STL-ZINC	2
10	1/4-20X1 25B	SCREW-SHCS-STL-BO	4
11	22800-24	GLASS SCALE-ENC 150 DIGITAL DIFF OUTPUT	1
12	22800-42	GLASS SCALE-ENC 150 DIGITAL DIFF OUTPUT	1

Figure 5-10
Glass Scale Alignment – DPM5, Sport B5, DPMS5

5.1.8 Power Drawbar – Optional for DPME2, DPMS3 and DPMS5

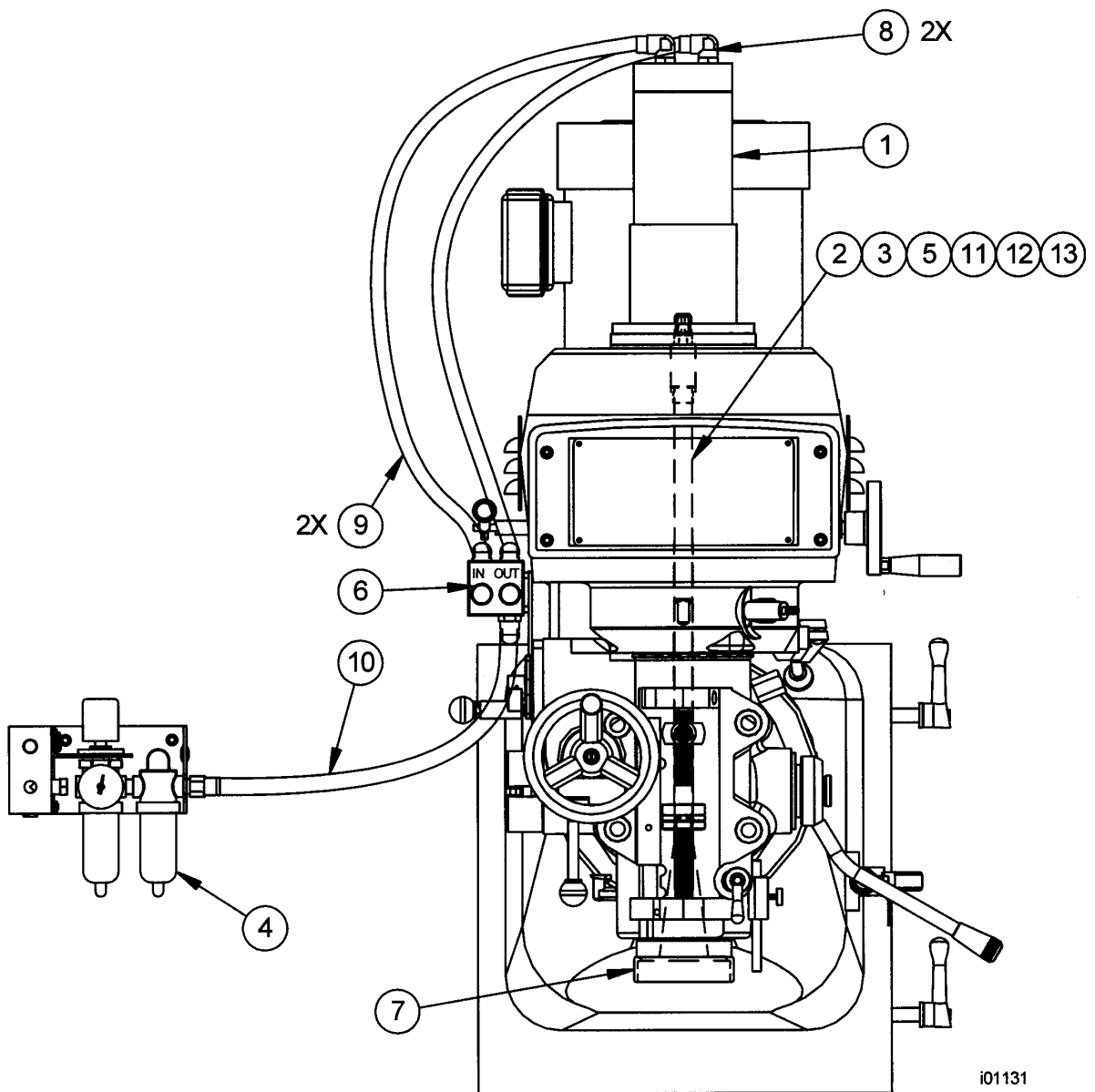
The optional power drawbar is bolted to the top of the head by the use of 3 SHCS. Some machines may require a washer to space the unit up to the proper height to allow the drawbar to engage properly.

Air Regulator and Oiler - This unit requires between 80 and 100 psi to operate properly. Some units work fine at 80 psi while others may need 90 or 100 psi. It is also important to make sure the oiler for this unit is kept filled with oil. Fill the reservoir about 2/3 full using AIR TOOL OIL ONLY. Failure to do this will not allow oil to lubricate the internal components of the unit and it may wear out prematurely. It is also important to make sure the oiler is set properly. To set the oiler, first close the adjustment screw (CW) on top of the oiler completely making sure to not over tighten. Then open the screw (CCW) between ½ to ¾ of a turn. Any more than this will cause too much oil to get into the unit and oil may come out of the exhaust port of the unit.

DPMS3 & DPMS5 only: Tool Alignment Device - This unit also comes with a tool alignment device, which attaches to the bottom of the spindle. This device allows the tool to easily be aligned with the dogs when loading a tool.

CAUTION!

Some tools may not work with this device and the original spindle dogs will need to be used. The original spindle dogs are shipped with each machine in the toolbox. Some boring bar holders may not work with this device.



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Figure 5-11
Power Drawbar Assembly

Parts List

Item	P/N	DESCRIPTION
1	22581-1	AIR GUN ASSY ONLY- TORQUE RITE
2	See table below	DRAWBAR
3	See table below	TOP WASHER
4	22380-2	AIR REGULATOR ASSY
5	See table below	DRAWBAR
6	22581-2	SWITCH - CONTROL HEAD - TORQUE RITE
7	22581-4	NOSEPIECE FOR SPINDLE
8	--	1/4" NPT AIR FITTING 90°
9	--	3/8 O.D. TUBING 132" LG.
10	--	3/8 O.D. TUBING 27" LG.
11	See table below	DRAWBAR
12	See table below	DRAWBAR
13	See table below	DRAWBAR

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Drawbar Table

Model Mill	Power Drawbar	Power Drawbar Spacer	Manual Drawbar	Manual Drawbar Spacer
DPME2	22605	22604	VS09	V5108
DPMS3/B3/TRM/DPM	22603-NMTB	21661	AK147L	AK149L
DPMS3/B3/TRM/DPM	22603-CAT	21661	AK147L	AK149L
DPMS5/B5	22641-NMTB	23888	FVS109	FVS108
DPMS5/B5	22641-CAT	23888	FVS109	FVS108

5.1.9 Ball Screw Replacement, X-Axis (Table)

Refer to the following chart for illustrations and parts lists of the X-axis drive assembly for each model.

X-axis Drive Train		
Machine Model	Figure	Ballscrew P/N
TRM	5-12	15608-48*
DPM	5-12	15608-48
DPM5	5-14	21564
Sport B3	5-12, 5-13	15608-48
Sport B5	5-14	21564
DPMS3	5-15	15608-48
DPMS5	5-16, 5-17	21564
DPME2	5-18	15608-48

*Early MX2TRM may have 42" table/ballscrews.

CAUTION!

Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

1. Position the table in the center of travel
2. Remove the X motor assembly.
3. Remove the motor mounting bracket and bearing housing.
4. Remove the right side bearing housing.
5. TRM & DPM only: Remove X-axis sensor guard cover and X TRAK sensor from its mounting base.
6. Loosen the table gibs. Slide the table to the right and on to a lift that will support the table's weight. Slide the table until the yoke is exposed.

CAUTION!

The weight of the table must be supported by the lift to prevent damage or breakage to the dovetails.

7. Remove the 5/16 x 1" screw holding the ball nut to the yoke and loosen the 4 screws that mount the yoke to the saddle. Remove the oil line.
8. Remove the Y-axis motor and bracket assembly. Tilt the yoke (it is pinned) to remove the X ball screw.
9. Remove the elbow and setscrew from the old ball screw flange and fit them similarly in the new ball screw.
10. Pump oil to be certain it flows through the oil line and then attach the oil line to the elbow.
11. Reassemble all assemblies.

Important: The clamp nut must be reassembled as follows:

- Install rear bearing and seal into bearing housing and slide housing onto the ball screw. *(Note: Letters on bearings must face each other in the housing.)*

- Thread the split nut onto the ball screw and tighten the #10-32 clamp screw until you feel the split nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Torque the split nut to 50 ft. lb.
- Firmly tighten the #10-32 clamp screw to lock the clamp nut in place.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

5.1.9.1 X-Axis Handwheel Box – DPMS5 only

(See Figure 5-17)

Teardown and Part Replacement

1. Remove top sheet metal cover (item #2).
2. Remove the manual hand wheel.
3. Release back cover hub (item #4).
4. Slide cover hub and shaft assembly (items # 12,3,9, and 4) out.
 - 4.a. Shaft assembly removal
 - 4.a.1. Slide shaft assembly (item #12, and # 3) off of back cover hub assembly (item #9 and #4).
 - 4.a.2. Loosen setscrew (item #14)
 - 4.a.3. Slide shaft gear off (item #12)
 - 4.a.4. Remove key (item #13)
5. Remove front hub assembly (item #5) from hand wheel box.
6. Remove gear (item # 11) at the end of the ball screw.
 - 6.a. Remove extension cover (item #8), use Allen wrench on item #14 to help support ball screw from rotating, and back out the extension cover support screw.
 - 6.b. Loosen setscrew (item #14)
 - 6.c. Slide Left Gear out
 - 6.d. Remove key (item #13)
7. Remove hand wheel box (item #1)
8. Remove ball screw extension (item #7)
 - 8.a. back out setscrews (item #14)
 - 8.b. back off extension by sliding a 3/16" Allen wrench through thru hole, pushing it up against the end of the ball screw pushing the extension slightly away from the bearing.
 - 8.c. Using two large screwdrivers pushing off the saddle, slide the extension off.
9. Use a mechanical puller to remove the bearing

Re-Assembly of Handwheel Box

1. Slide bearing on to the end of the ball screw (item #9), use a socket or piece of aluminum tubing and a dead blow hammer to tap bearing till it flushes up against the step of the ball screw.
2. Slide the extension on and flush it up against the bearing, lock down with both setscrews (item #14). Item 19 can be used to push the extension from the end of the ball screw to adjust the gear spacing.
3. Bolt the handwheel box (item # 1) down.
4. Bolt the front hub assembly (items #6, 10, and 5) on.
5. Slide the shaft assembly (items # 3, 12, 9, and 4) in through the backside and bolt the cover hub on.

CAUTION!

Assemble the hand wheel, move it back and forth, and see if there is some play in meshing the two gears together. If the gears mesh tightly against one another it can generate noise during movement of the X-axis. It is normal to have a small amount of backlash between the gears.

6. Screw on top cover.

Parts List - X Drive Assembly - TRM, DPM & Sport B3

NO.	P/N	DESCRIPTION	QTY
1	15974	END PLATE	1
2	15973	ADAPTER SERVO MOTOR	1
9	15638	STOP "X" AXIS	1
12	14772	SPACER	4
15	15613	CLAMP NUT	1
16	400-5M-15	BELT - TIMING 5 MM HTD	1
17	15612	HOUSING - BEARING	1
18	20373	BEARING - ANG CONTACT	2
19	15885	RING - BEARING	1
20	15626	SEAL	1
23	15616	HANDWHEEL - ASSY	1
25	15180	SHAFT EXTENSION	1
26	15058-.875	BUSHING - EXTENSION	1
29	15976	TRAY (C15976)	1
30	15977	FLAT RIB RUBBER MATING - PAO McMASTER CARR # 6972T3	1
31	204KTT	BALL BEARING	1
33	10-32x3/4	SCREW - SOC HD CAP STL BLK OX	1
34	14772-5	SPACER - .005	3
35	14772-2	SPACER - .02	1
36	16865-1	PULLEY - SOLID 44 TOOTH	1
37	16864	SLEEVE - TAPERED	1

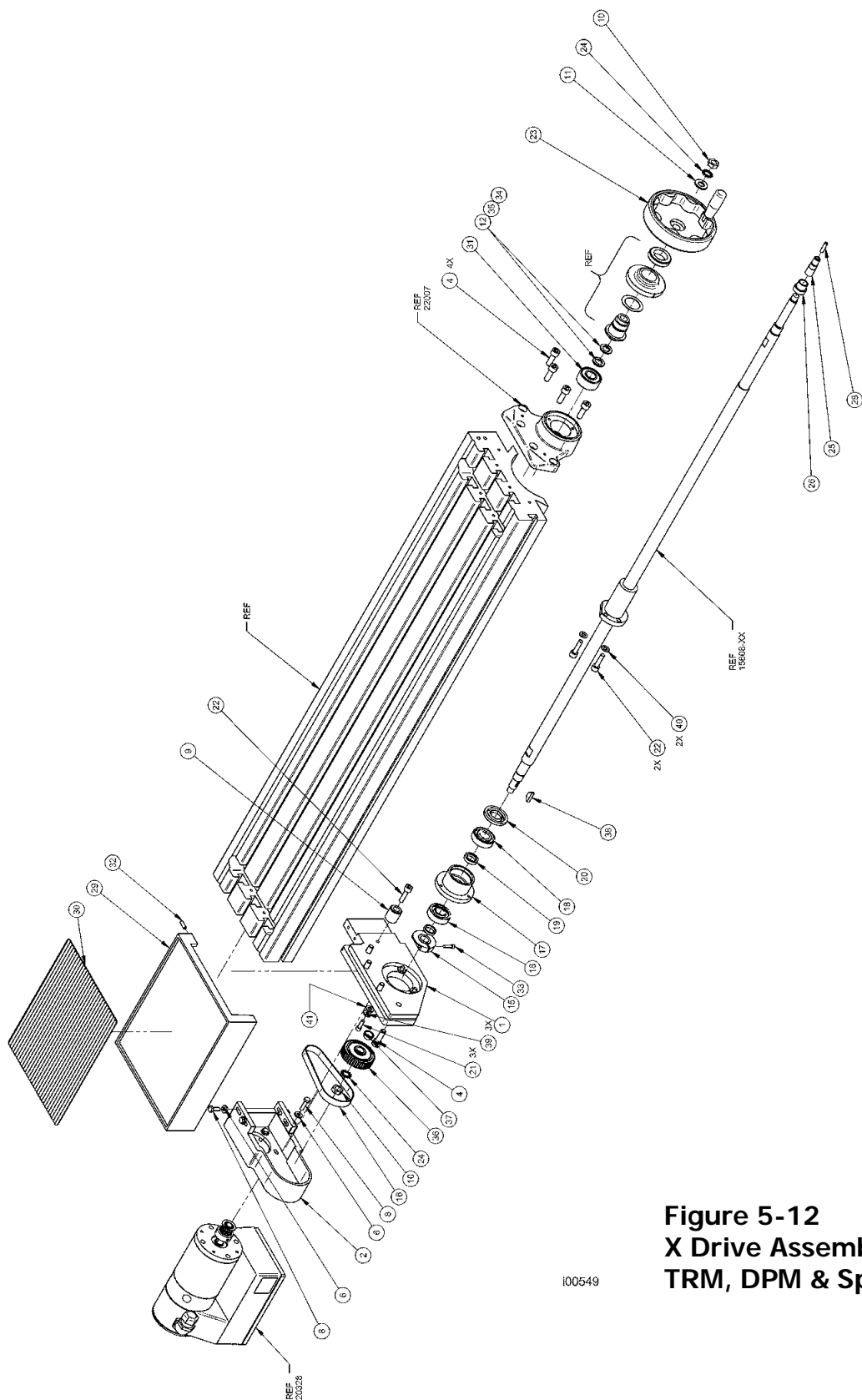
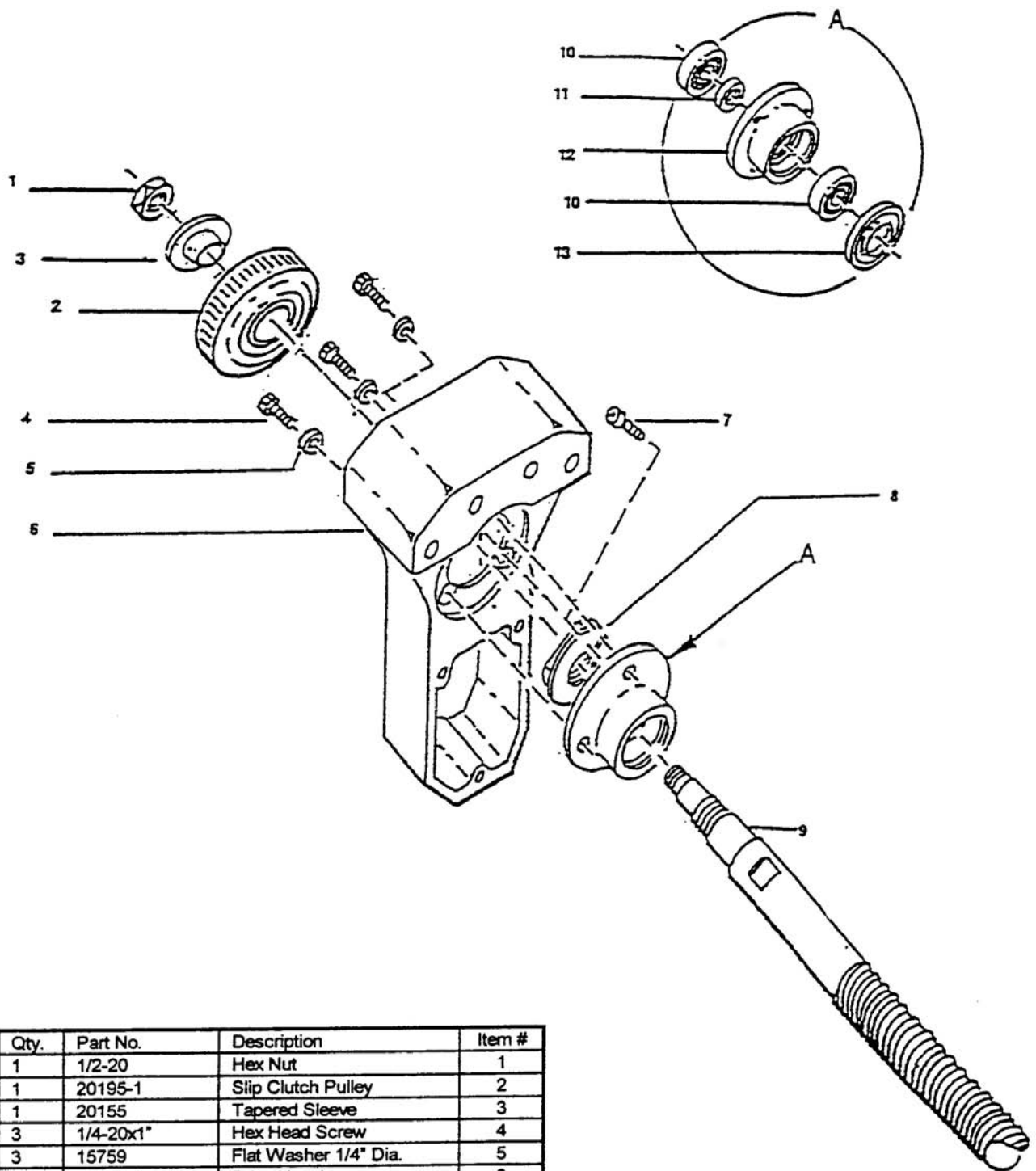


Figure 5-12
X Drive Assembly for
TRM, DPM & Sport B3

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Qty.	Part No.	Description	Item #
1	1/2-20	Hex Nut	1
1	20195-1	Slip Clutch Pulley	2
1	20155	Tapered Sleeve	3
3	1/4-20x1"	Hex Head Screw	4
3	15759	Flat Washer 1/4" Dia.	5
1	15621-1	Drive Housing	6
1	10-32x3/4	Socket Head Cap Screw	7
1	15613	Clamp Nut	8
1	15608-36,42,48	Ballscrew	9
2	7204BECBP	Angular Contact Bearing	10
1	15885	Bearing Ring	11
1	15612	Bearing Housing	12
1	15626	Bearing Seal	13

Figure 5-13
X Drive Assembly,
Left Side – DPME2

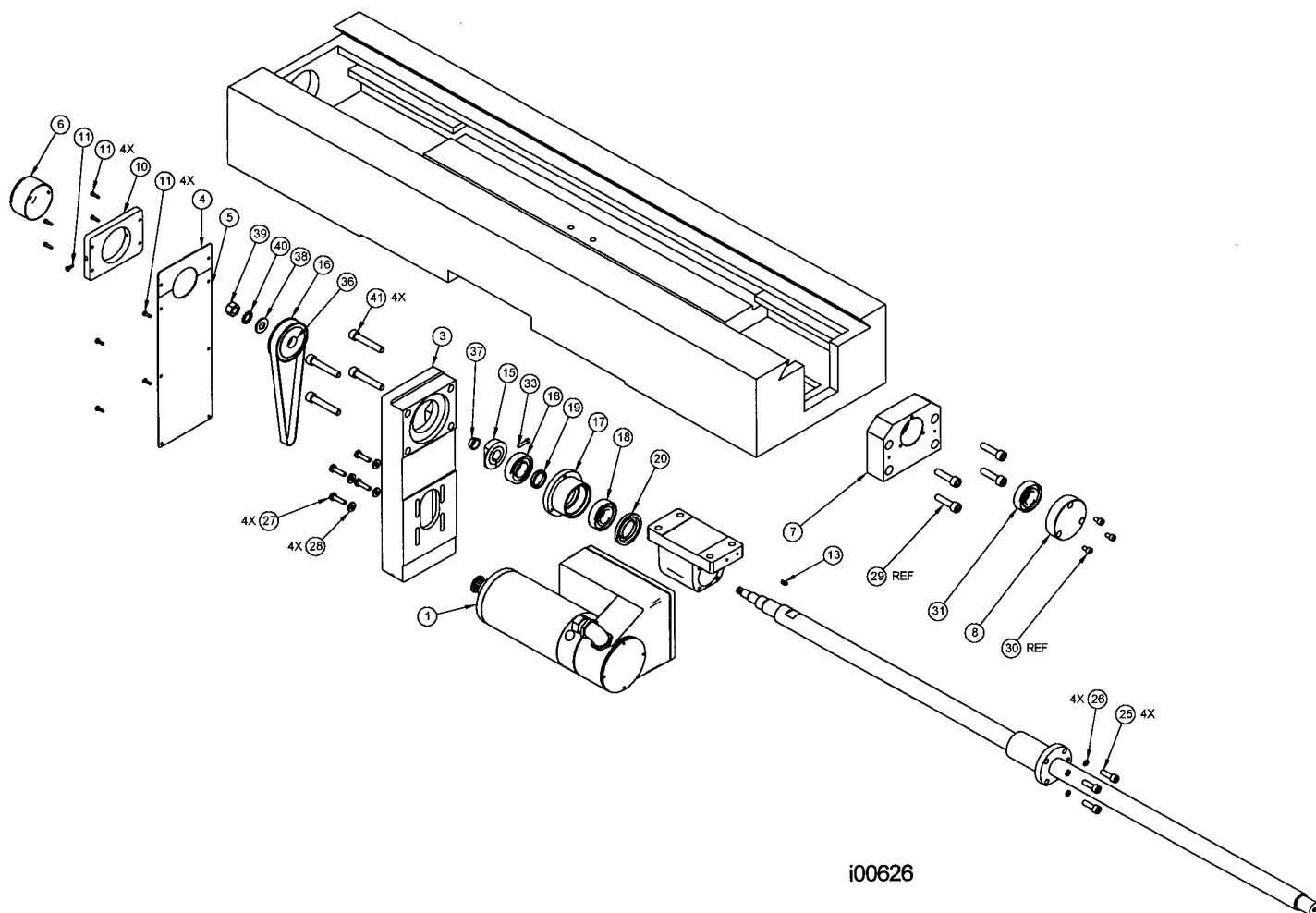
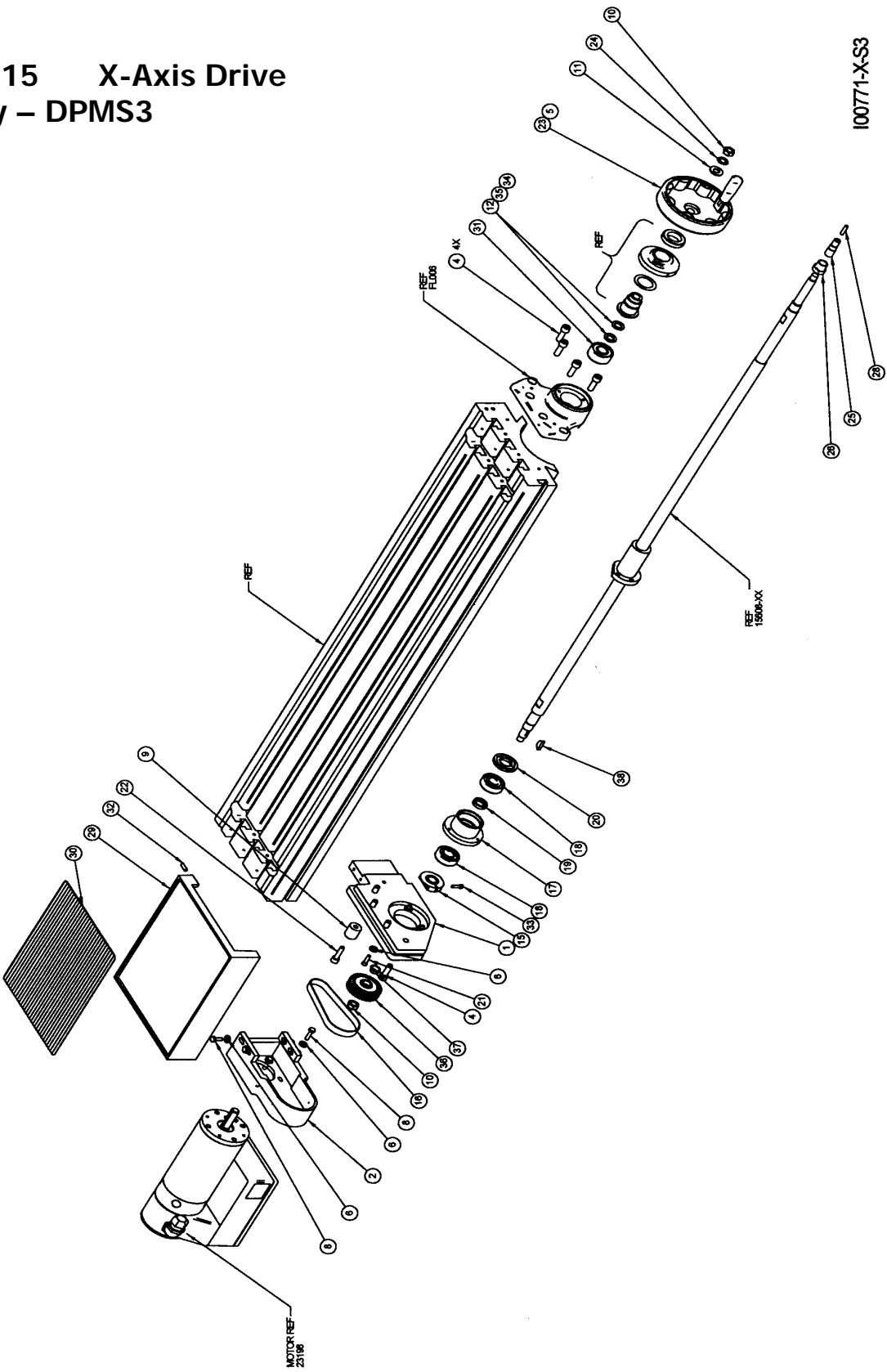


Figure 5-14
X-Drive Assembly – DPM5 & Sport B5DD

Parts List, X Drive Assembly - DPM5 & Sport B5

NO.	P/N	DESCRIPTION	QTY
1	21685	MOTOR DRIVER ASSY-	REF
3	15966-2	BRACKET- MOTOR MOUNT	1
4	15967-2	COVER- UPPER	1
5	15968-2	COVER- LOWER	1
6	21585-2	COVER- BALL SCREW END	1
7	21573	BEARING HOUSING-	REF
8	21572	COVER- BALL SCREW END	REF
10	21584-2	END COVER PLATE	1
11	6-32 x 1/2 10B	SCREW- PAN HD, EXT SEMS, STL, BLK OX	9
13	98481A090	KEY- WOODRUFF 1/8 x 1/2	1
15	16066	CLAMP NUT	1
16	565-5M-15	BELT - TIMING 5 MM HTD	1
17	21662	BEARING HOUSING- X AXIS	1
18	20374	BEARING - ANG CONTACT	2
19	16302	RING - BEARING	1
20	16078	SEAL	1
25	M8-1.25 x 25 25B	SCREW- SOC HD CAP, BLK OZ	4
26	M8 74B	WASHER- EXTERNAL TOOTH	4
27	1/4-20 x 1 24B	SCREW- HEX HD	4
28	15759	WASHER- FLAT 1/4	4
29	M10-1.5 x 40 25B	SCREW- SOC HD CAP, BLK OX	REF
30	M6-1.0 x 10 25B	SCREW- SOC HD CAP, BLK OX	REF
31	6205	BALL BEARING- DEEP GROOVE	REF
33	10-32 x 3/4 25B	SCREW- SOC HD CAP, BLK OX	1
36	16983-1	PULLEY - SOLID 44 TOOTH	1
37	16350	SLEEVE - TAPERED	1
38	1/2	WASHER- FLAT 1/4	1
39	91079A033	NUT- JAM 1/2-20 51Z	1
40	1/2 75C	WASHER- EXT TOOTH	1
41	M10-1.5 x 65	SCREW- SOC HD CAP, BLK OX	4

Figure 5-15 X-Axis Drive Assembly – DPMS3



100771-X-S3

DPMS3 X-Axis Drive Assembly Parts List

Item	P/N	Description	Qty
1	15974	END PLATE	1
2	15973	SERVO MOTOR ADAPTER	1
4	M10-1.5X30 25B	SCREW-SHCS-STL-BO	8
5	15614	TAB WASHER	1
6	15759	WASHER-1/4 HARD BLK OX 1/8 THK	11
8	1/4-20X1 24B	SCREW-HEX HD-STL-BO	8
9	15638	STOP - X-AXIS	1
10	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
11	1/2 70P	WASHER-FLAT USS-STL-PLAIN	1
12	14772	SPACER - .100" THICK	4
15	16452	NUT CLAMP-X, Y, & Z AXIS	1
16	425-5M-15	BELT-TIMING 5 MM POWERGRIP	1
17	15612	HOUSING - BEARING	1
18	20373	BEARING-ANGULAR CONTACT- 7204 BECBP	2
19	15885	RING-BEARING HOUSING	1
20	15626	SEAL-BEARING HOUSING	1
21	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	3
22	5/16-18X1 1/4 25B	SCREW-SHCS-STL-BO	1
23	15616	HANDWHEEL ASSY-MX	1
24	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
25	15180	SHAFT-EXTENSION 1"	1
26	15058-.875	BUSHING	1
28	1/4-28X1 43B	SCREW-SOC SET-STL-BO-KNURLED	1
29	22069	TRAY MACHINE	1
30	15977	TRAY PAD	1
31	22008	BEARING-204KTT	1
32	1/4-28X3/4 42B	SCREW-SOC SET-STL-BO-CONE	1
33	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
34	14772-5	SPACER - .050" THICK	3
35	14772-2	SPACER - .020" THICK	1
36	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
37	16350	FERRULE-SPROCKET	1
38	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1

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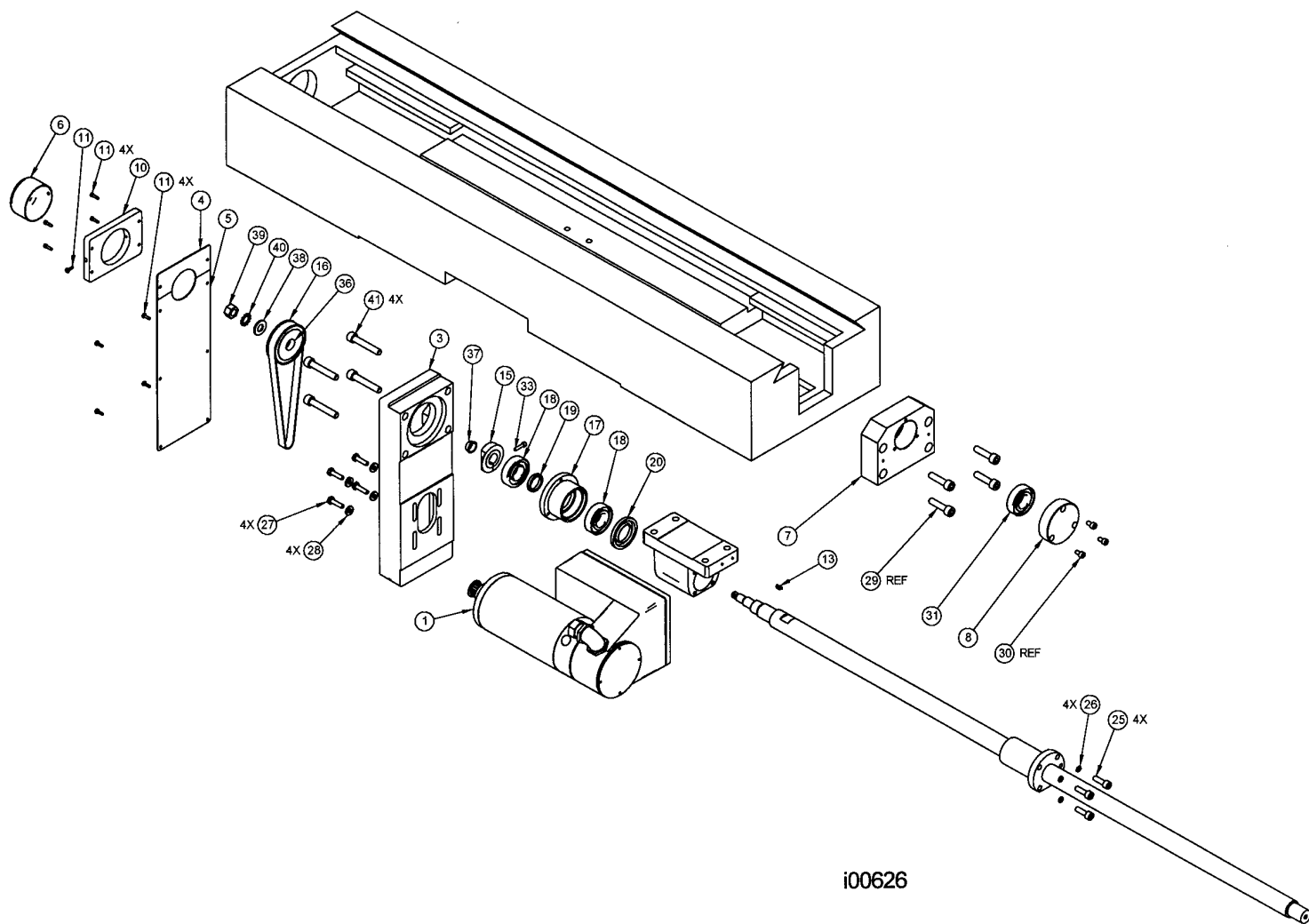


Figure 5-16 X Drive Train – DPMS5

DPMS5 X Drive Train Parts List

Item	P/N	Description	Qty
3	15966	BRACKET-Y AXIS MOTOR MOUNT	1
4	15967	COVER-UPPER	1
5	15968	COVER-LOWER	1
6	21585-1	COVER-BALL SCREW END	1
10	21584-1	PLATE-END COVER	1
11	6-32X1/2 10B	SCREW-PH-PHIL-STL-BO	9
13	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
15	16066	NUT CLAMP-X & Y AXIS	1
16	600-5M-15	BELT-TIMING	1
17	21662	BEARING HOUSING-	1
18	20374	BEARING-ANGULAR CONTACT-7205 BECBP	2
19	16302	RING-BEARING HOUSING	1
20	16078	SEAL-BEARING HOUSING	1
22	M10-1.5 50P	NUT-HEX-STL-PLAIN	2
23	M10 73B	WASHER-SPLIT LOCK-STL-BO	2
25	M8-1.25X25 25B	SCREW-SHCS-STL-BO	4
26	M8 74B	WASHER-EXT TOOTH-STL-BO	4
27	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
28	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
33	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
36	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
37	16350	FERRULE-SPROCKET	1
38	1/2 70P	WASHER-FLAT USS-STL-PLAIN	2
39	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
40	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	2
41	M10-1.5X75 25B	SCREW-SHCS-STL-BO-FULLY THD	8
42	15616	HANDWHEEL ASSY-MX	1
43	15614	TAB WASHER	1

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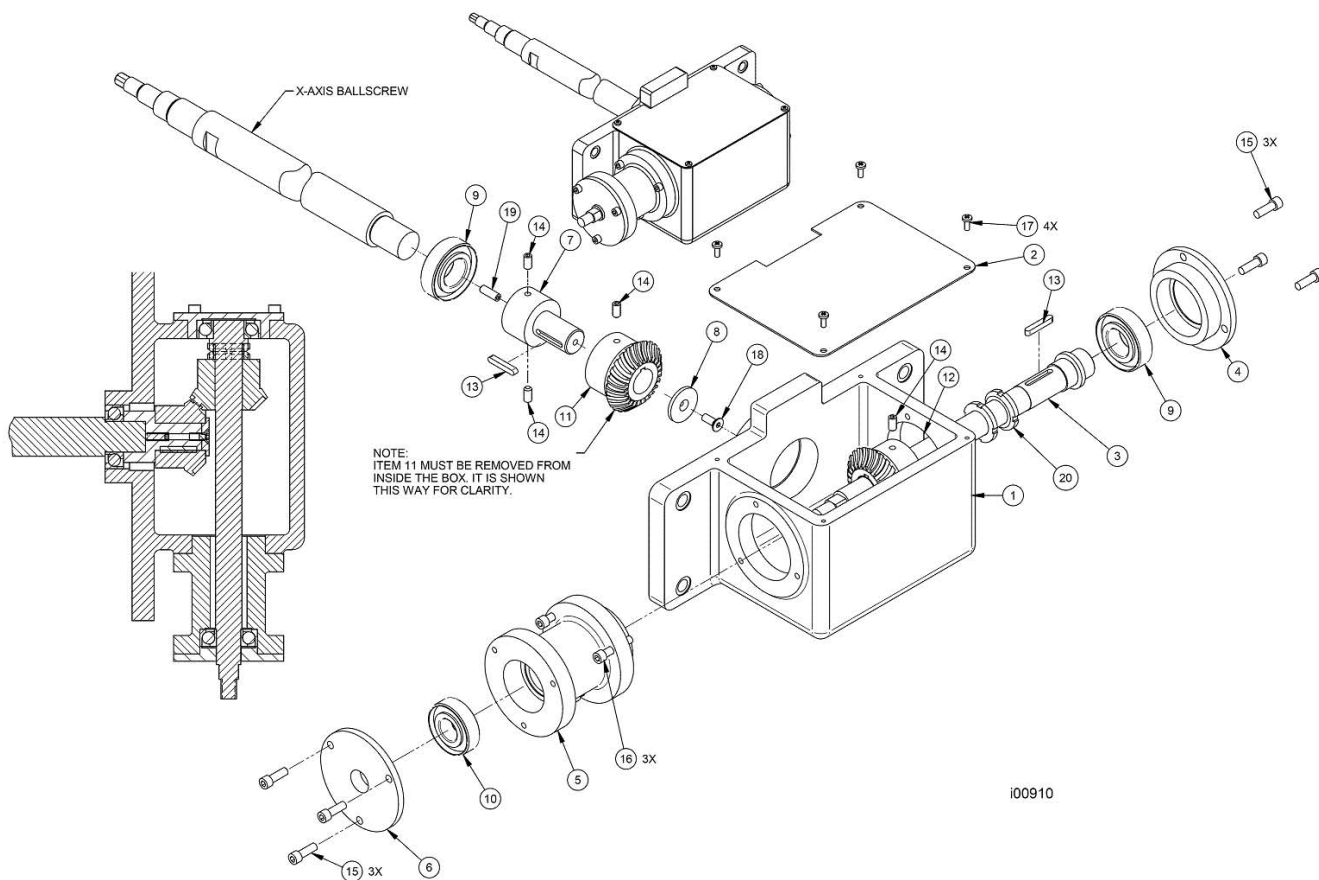
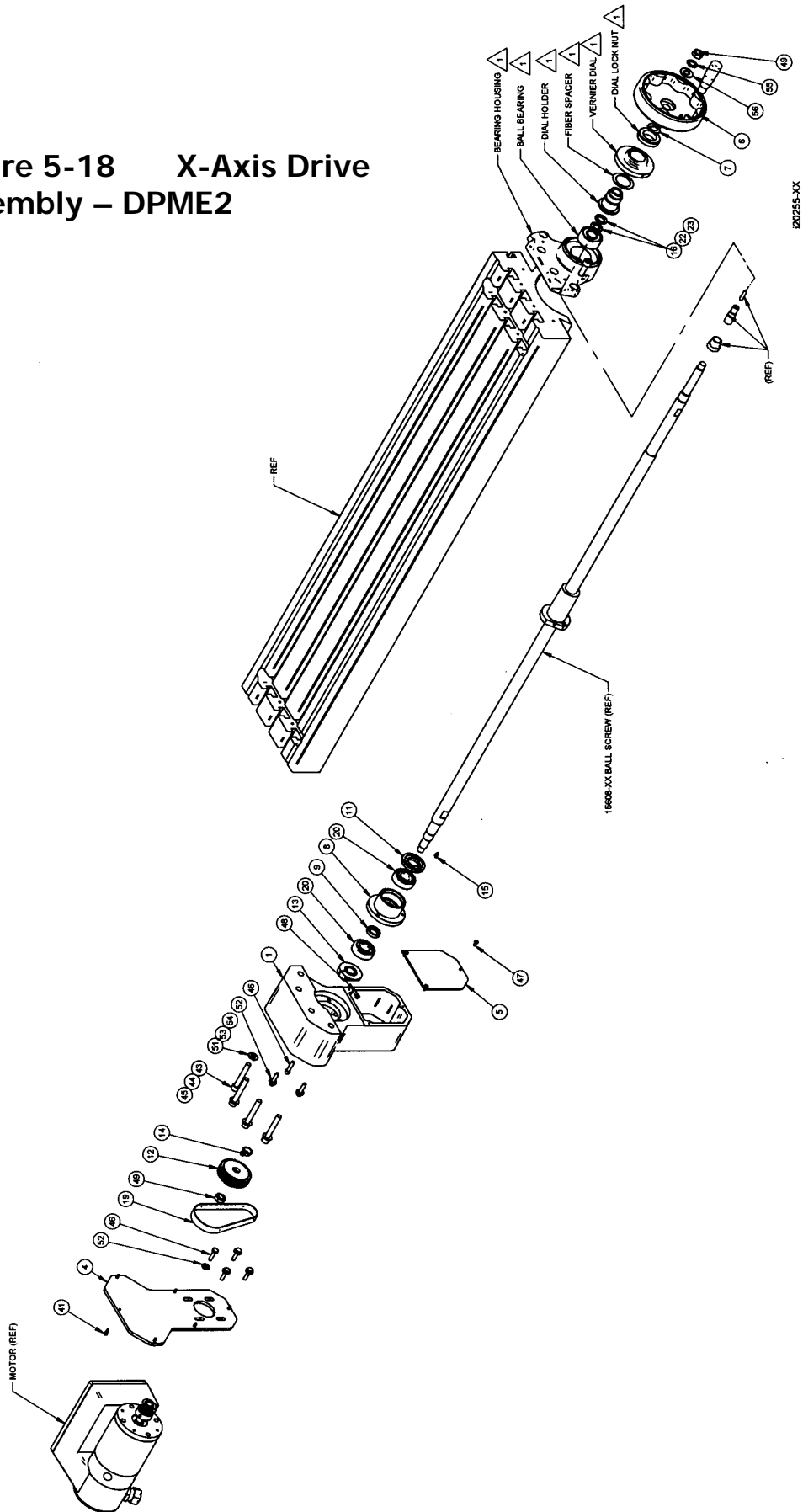


Figure 5-17 X Handwheel Drive Mechanism – DPMS5 only

X Handwheel Drive Mechanism Parts List – DPMS5 only P/N 23021 – Gear Box Assembly

Item	P/N	Description	Qty
1	23014	HANDWHEEL BOX-X AXIS	1
2	23015	SHEET METAL-PT4-COVER-X AXIS-HANDWHEEL BOX	1
3	23019	SHAFT-X AXIS-HANDWHEEL BOX	1
4	23017	COVER-HUB-X AXIS-HANDWHEEL BOX	1
5	23018	HUB-X AXIS-HANDWHEEL BOX	1
6	23020	COVER-X AXIS-HANDWHEEL BOX	1
7	23027	EXTENSION-BALL SCREW-X AXIS-HANDWHEEL ASSY	1
8	23028	COVER-EXTENSION-BALL SCREW-X AXIS-HANDWHEEL ASSY	1
9	6205ZZ	BEARING-DEEP GROOVE	2
10	6204ZZ	BEARING-	1
11	23033-L	GEAR-HARDENED STEEL SPIRAL MITER-LEFT	1
12	23033-R	GEAR-HARDENED STEEL SPIRAL MITER-RIGHT	1
13	3/16X1	KEY-3/16X1	2
14	1/4-20X1/2 40B	SCREW-SOC SET-STL-BO-CUP	6
15	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	6
16	1/4-28X1 1/4 25B	SCREW-SHCS-STL-BO	3
17	1/4-20X1/2 27B	SCREW-BHCS-STL-BO	4
18	1/4-20X5/8 26B	SCREW-FHCS-STL-BO	1
19	1/4-20X3/4 40B	SCREW-SOC SET-STL-BO-CUP	1

Figure 5-18 X-Axis Drive Assembly – DPME2



X-Axis Drive Assembly Parts List – DPME2

Item	P/N	Description	Use As	Qty
1	15621	DRIVE HOUSING	EA	1
4	15624	FRONT COVER	EA	1
5	15622	BACK COVER	EA	1
6	15616	HANDWHEEL ASSY-MX	EA	1
7	15614	TAB WASHER	EA	1
8	15612	HOUSING - BEARING	EA	1
9	15885	RING-BEARING HOUSING	EA	1
10	15638	STOP - X-AXIS	EA	1
11	15626	SEAL-BEARING HOUSING	EA	1
12	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	EA	1
13	16452	NUT CLAMP-X, Y, & Z AXIS	EA	1
14	16350	FERRULE-SPROCKET	EA	1
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2	EA	1
16	14772	SPACER - .100" THICK	EA	5
19	400-5M-15	BELT - TIMING 5 MM POWERGRIP	EA	1
20	20373	BEARING-ANGULAR CONTACT- 7204 BECBP	EA	2
22	14772-2	SPACER - .020" THICK	EA	2
23	14772-5	SPACER - .050" THICK	EA	2
41	8-32X3/8 25B	SCREW-SHCS-STL-BO	EA	6
42	5/16-18X1 25B	SCREW-SHCS-STL-BO	EA	1
45	M10-1.5X65 25B	SCREW-SHCS-STL-BO	EA	4
46	1/4-20X1 24B	SCREW-HEX HD-STL-BO	EA	7
47	8-32X3/8 20B	SCREW-RH-PHIL-STL-BO	EA	3
48	10-32X3/4 25B	SCREW-SHCS-STL-BO	EA	1
49	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	EA	2
52	15759	WASHER-1/4 HARD BLK OX 1/8 THK	EA	7
54	M10 70P	WASHER-FLAT USS-STL-PLAIN	EA	4
55	1/2 73B	WASHER-SPLIT LOCK-STL-BO	EA	1
56	1/2 70P	WASHER-FLAT USS-STL-PLAIN	EA	1

i20255-2

5.1.10 Ball Screw Replacement, Y-Axis (Saddle)

Refer to the following chart for illustrations and parts lists of the Y-axis drive assembly for each model.

Y-axis Drive Train		
Machine Model	Figure	Ballscrew P/N
TRM	5-19, 5-20	15609-16
DPM	5-19, 5-20	15609-16
DPM5	5-21	21564
Sport B3	5-22	15609-16
Sport B5	5-21	21564
DPMS3	5-23	15609-16
DPMS5	5-24	21564
DPME2	5-25	15609-16

CAUTION!

Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

1. Position the saddle all the way forward.
2. Remove the hand wheel assembly and bracket.
3. Remove the sheet metal covers on the front of the machine bed and on the motor mounting bracket.
4. Remove the motor, then remove the motor mounting bracket.
5. Remove the rest of the parts on the ball screw journal. Note the orientation of the bearings for reassembly.
6. Remove the 5/16 x 1 inch screw that attaches the ball nut to the yoke.
7. Remove the ball screw and oil line attached to the elbow fitting on the ball nut.
8. Remove the elbow and setscrew from the old ball screw flange and fit them similarly in the new ball screw.
9. Pump oil to be certain it flows through the oil line, and then attach the oil line to the elbow.
10. Reassemble all assemblies.

Important: The clamp nut must be reassembled as follows:

- Install rear bearing and seal into bearing housing and slide housing onto the ball screw. (*Note: Letters on bearings must face each other in the housing.*)
- Thread the split nut onto the ball screw and tighten the #10-32 clamp screw until you feel the split nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Torque the split nut to 50 ft. lb.
- Firmly tighten the #10-32 clamp screw to lock the clamp nut in place.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

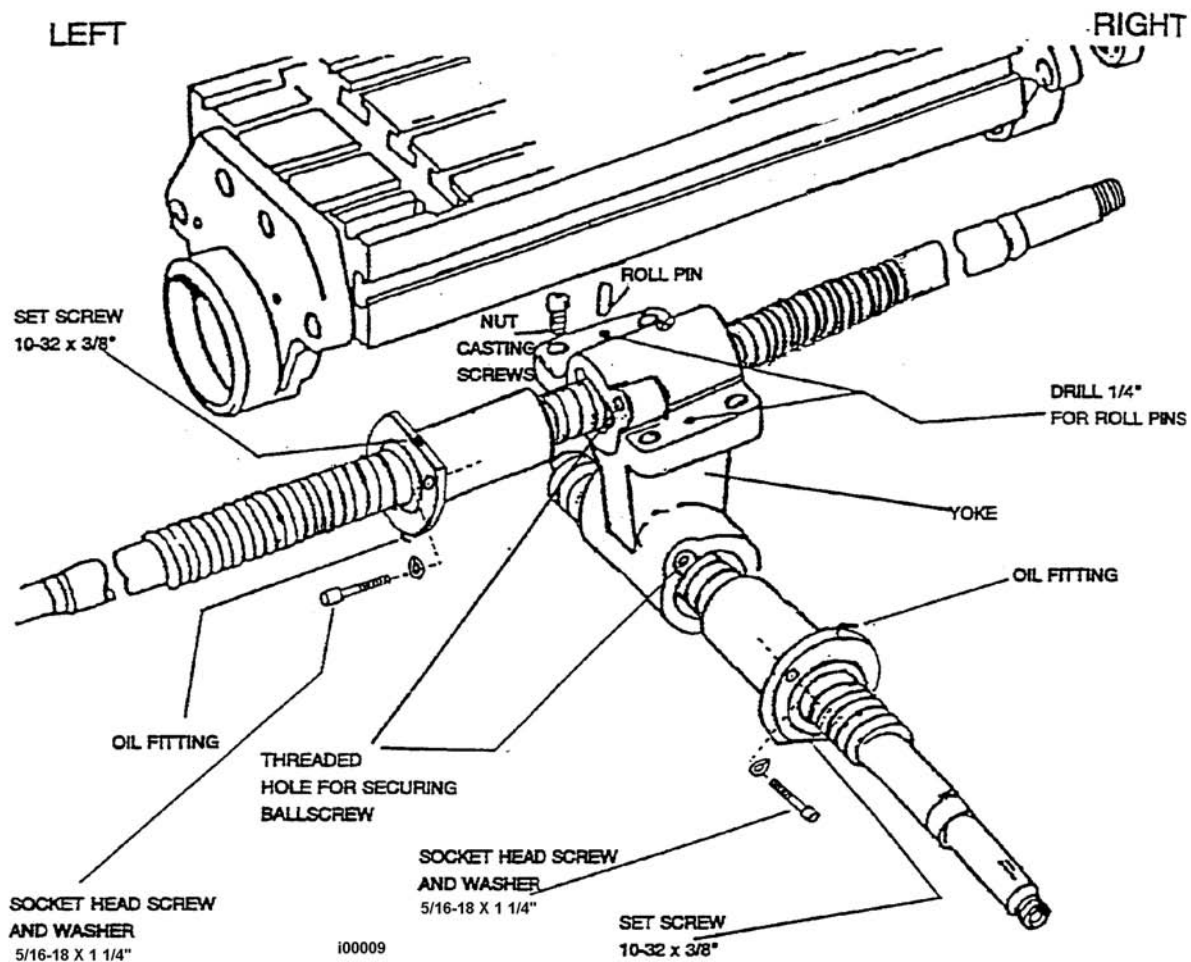


Figure 5-19
Ball Screw
Yoke Assembly – P/N 15990
TRM & DPM

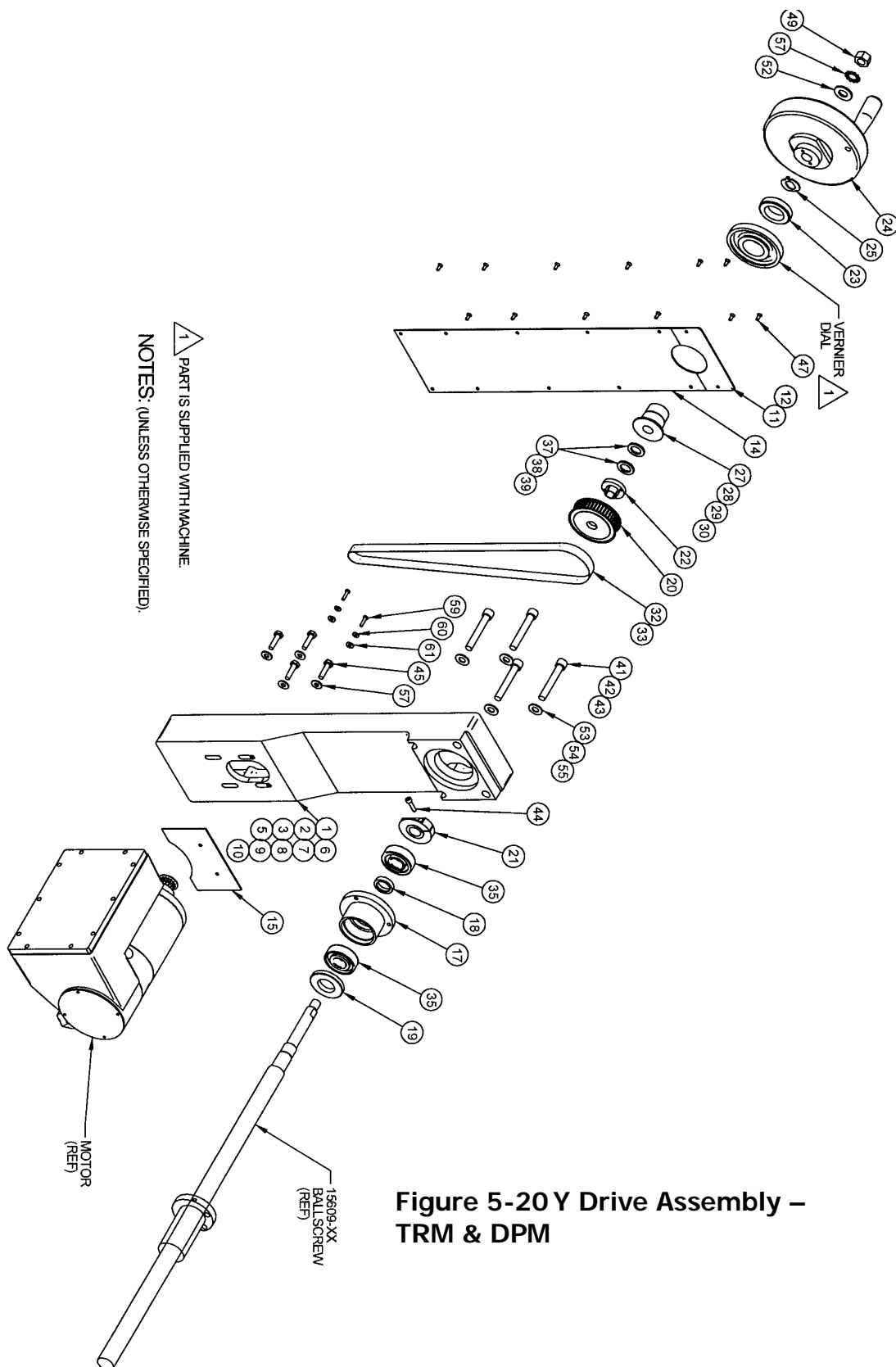


Figure 5-20 Y Drive Assembly – TRM & DPM

Y Drive Assembly Parts List - TRM & DPM

Item	P/N	Description	Qty
1	15966	BRACKET-Y AXIS MOTOR MOUNT	1
3	15968	COVER-LOWER	1
4	15967	COVER-UPPER	1
9	15616	HANDWHEEL ASSY-MX	1
12	15614	TAB WASHER	1
13	14772	SPACER - .100" THICK	1
14	15980	BEARING HOUSING	1
15	20373	BEARING-ANGULAR CONTACT- 7204 BECBP	2
16	15885	RING-BEARING HOUSING	1
17	15626	SEAL-BEARING HOUSING	1
19	20195-2	SLIP CLUTCH ASSY 125 LBS-INCH	1
20	15613	CLAMP NUT-BEARING HOUSING	1
21	565-5M-15	BELT-TIMING	1
22	15627-1	DIAL HOLDER	1
23	15913	BRACKET-WAY COVER FRONT	1

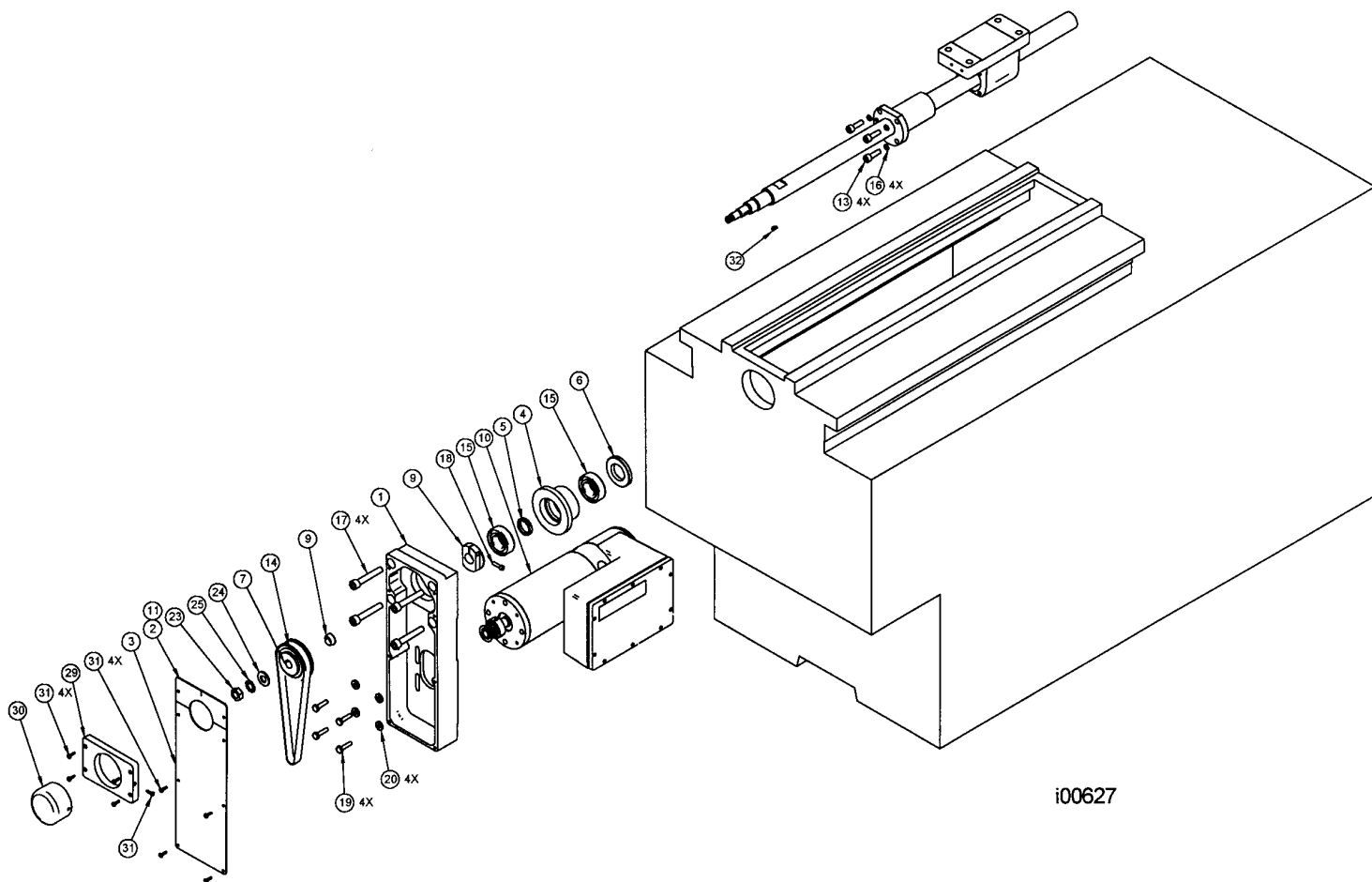


Figure 5-21 Y Drive Assembly – DPM5 & Sport B5

Parts List, Y Drive Assembly – DPM5 & Sport B5

NO.	P/N	DESCRIPTION	QTY
1	15966-2	BRACKET - MOTOR MOUNT	1
2	15967-2	COVER - UPPER	1
3	15968-2	COVER - LOWER	1
4	21662	BEARING HOUSING	1
5	16302	BEARING RING	1
6	16078	SEAL - BEARING	1
7	16983-1	PULLEY - 44 TOOTH	1
8	16066	NUT - CLAMP	1
9	16350	SLEEVE - TAPERED	1
10	21685	MOTOR DRIVER ASSY-	REF
11	15913-2	COVER- UPPER	1
13	M8-1.25 x 25	SCREW- SOC HD CAP BLK OX	4
14	565-5M-15	TIMING BELT	1
15	20374	BEARING	2
16	M8 74B	WASHER EXTERNAL TOOTH	4
17	M10-1.5 X 65	SCREW - SOC HD CAP, BLK OX	4
18	10-32 x 3/4 25B	SCREW - SOC HD CAP, BLK OX	1
19	1/4-20 x 1 24B	SCREW - HEX HEAD	4
20	15759	WASHER- FLAT 1/4	4
23	91079A033	NUT - JAM, ZINC PLATE, 1/2-20	1
24	1/2 70Z	WASHER - FLAT, STL, ZINC	1
25	1/2 75C	WASHER- EXT TOOTH	1
28	3/16 x 1 1/2	PIN - SPRING, STL, PLAIN	2
29	21584-2	END COVER PLATE	1
30	21585-2	END COVER- BALL SCREW	1
31	6-32 x 1/2 10B	SCREW- PAN HD PHIL EXT SEMS	9
32	98481A090	KEY- WOODRUFF 1/8 x 1/2	1

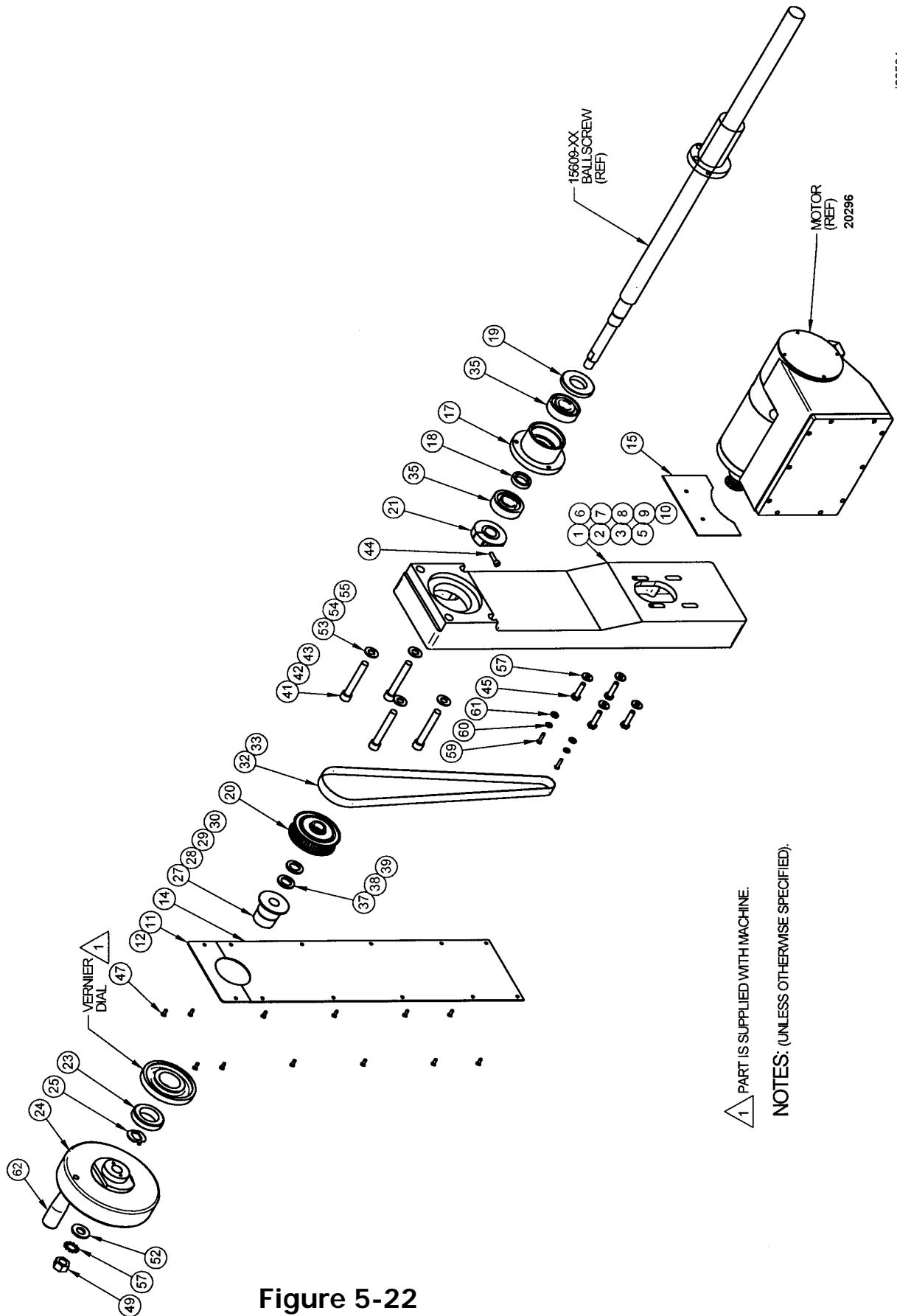
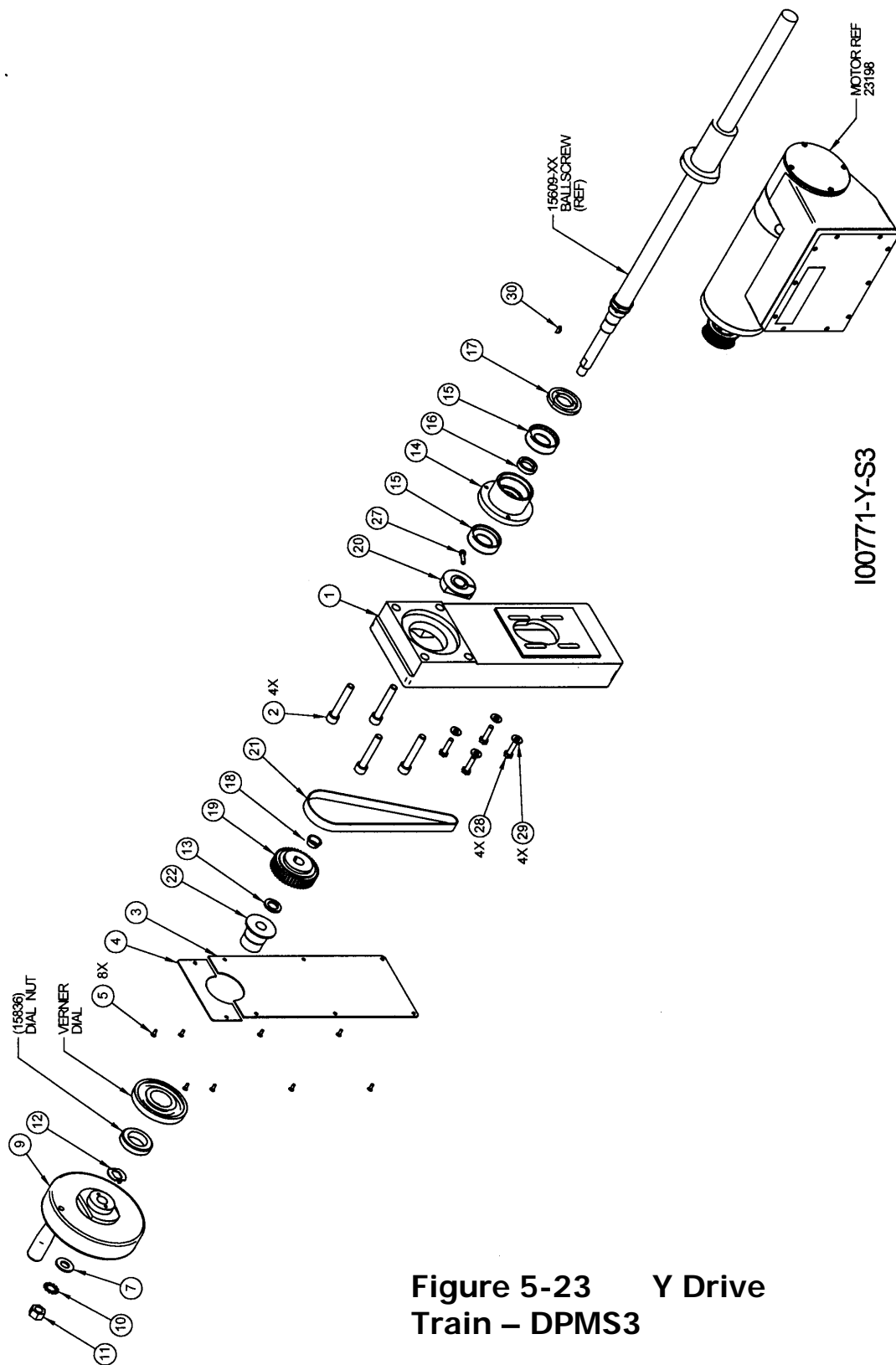


Figure 5-22
Y Drive Assembly – Sport B3

Y Drive Assembly Parts List - Sport B3

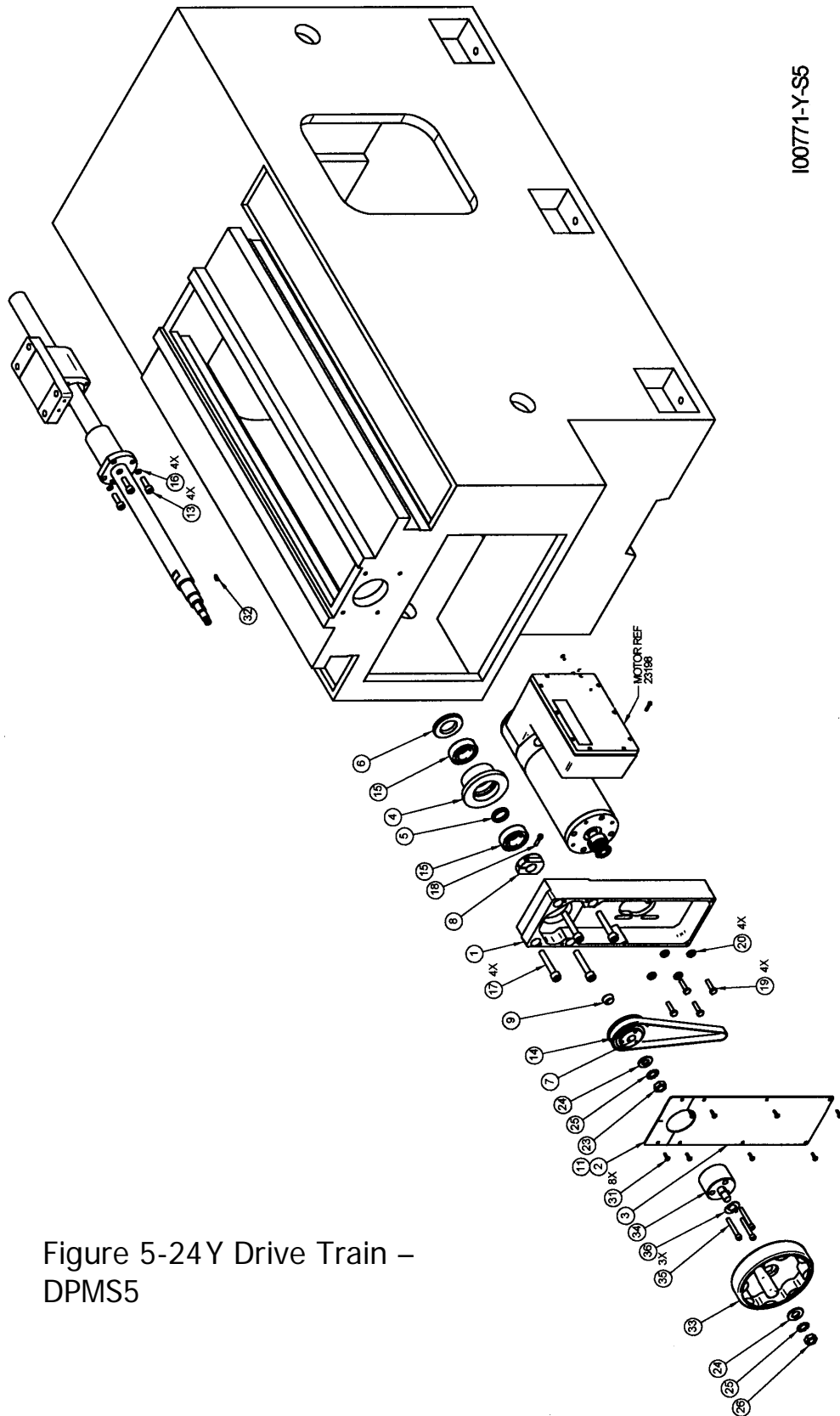
ITEM	P/N	DESCRIPTION	QTY
1	15966-2	BRACKET - MOTOR MOUNT	1
11	15967-2	COVER - UPPER	1
14	15968-2	COVER - LOWER	1
17	15980	BEARING HOUSING	1
18	15885	BEARING RING	1
19	15626	SEAL - BEARING	1
20	16865-2	SPROCKET - 44 TOOTH	1
21	15613	NUT - CLAMP	1
22	16864	SLEEVE - TAPERED SPRO.	
23	15836	DIAL NUT	1
24	15616-1	HANDWHEEL	1
25	15614	WASHER - TAB	1
27	15627-1	DIAL HOLDER	1
32	565-5M-15	TIMING BELT	1
35	20373	BEARING	2
37	14772	SPACER	2
41	M10-1.5 X 60	SCREW - SOC HD CAP, BLK OX	4
	10-32 x 3/4	SCREW - SOC HD CAP, BLK OX	4
45	1/4-20 x 1	SCREW - HEX HEAD	4
47	6-32 x 3/8	SCREW - FLAT HEAD, BLK OX	12
49	91079A033	NUT - JAM, ZINC PLATE, 1/2-20	1
52	1/2 DIA	WASHER - FLAT	1
53	M10	WASHER - FLAT	4
57	1/4 DIA (15759)	WASHER - FLAT	4
62	30922	FOLD-AWAY HANDLE	1



Y Drive Train Parts List – DPMS3

Item	P/N	Description	Qty
1	15966	BRACKET-Y AXIS MOTOR MOUNT	1
2	M10-1.5X60 25B	SCREW-SHCS-STL-BO	4
3	15968	COVER-LOWER	1
4	15967	COVER-UPPER	1
5	6-32X3/8 31Z	SCREW-PH-PHIL-EXT SEMS-STL-ZINC	8
7	1/2 70P	WASHER-FLAT USS-STL-PLAIN	1
9	15616	HANDWHEEL ASSY-MX	1
10	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
11	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
12	15614	TAB WASHER	1
13	14772	SPACER - .100" THICK	1
14	15980	BEARING HOUSING	1
15	20373	BEARING-ANGULAR CONTACT- 7204 BECBP	2
16	15885	RING-BEARING HOUSING	1
17	15626	SEAL-BEARING HOUSING	1
18	16350	FERRULE-SPROCKET	1
19	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
20	16452	NUT CLAMP-X, Y, & Z AXIS	1
21	600-5M-15	BELT-TIMING	1
22	15627-1	DIAL HOLDER	1
23	15913	BRACKET-WAY COVER FRONT	1
27	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
28	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
29	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1

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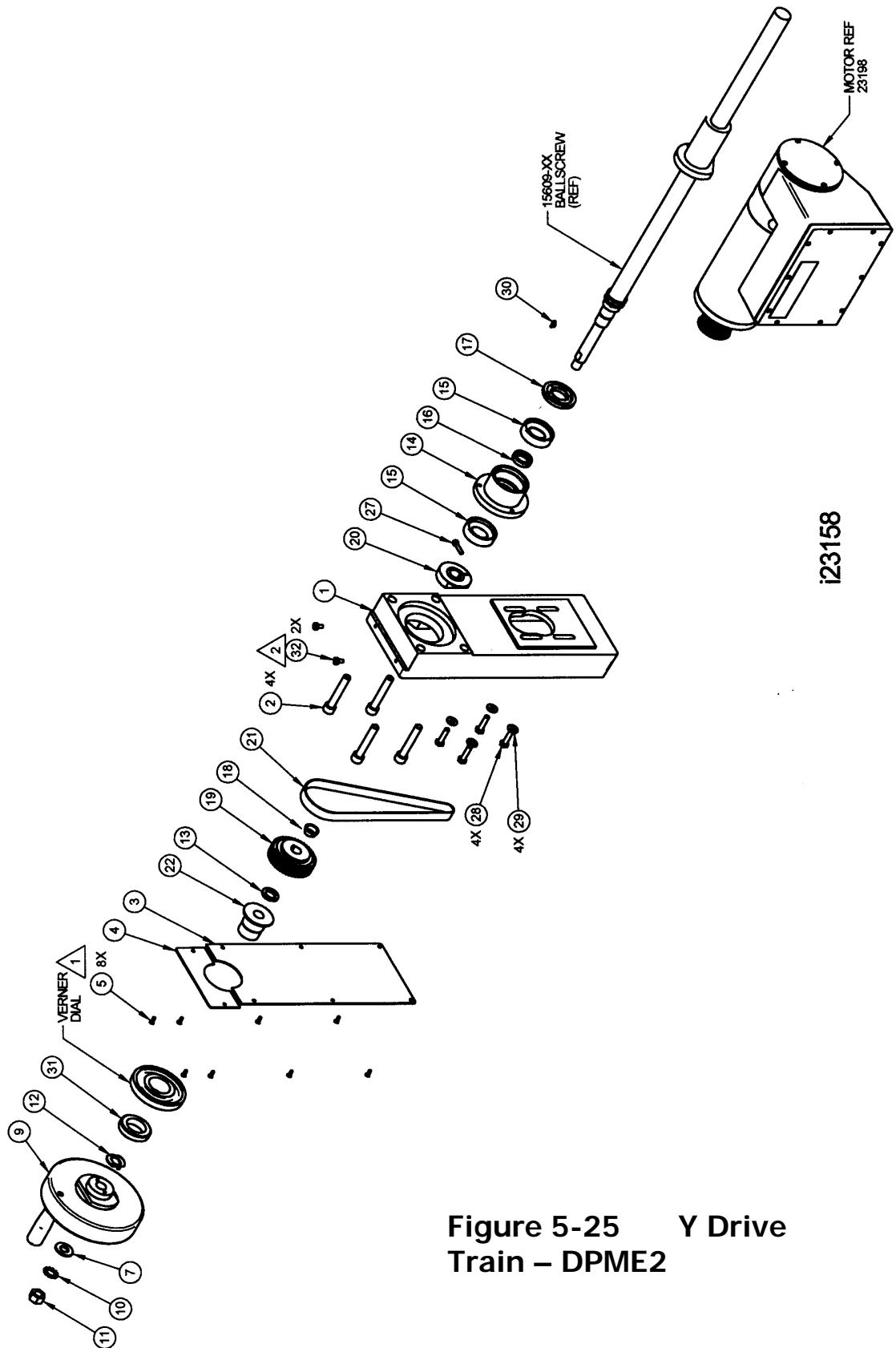
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Figure 5-24 Y Drive Train – DPMS5

Y Drive Train Parts List – DPMS5

Item	P/N	Description	Qty
1	15966	BRACKET-Y AXIS MOTOR MOUNT	1
2	15967	COVER-UPPER	1
3	15968	COVER-LOWER	1
4	21662	BEARING HOUSING-	1
5	16302	RING-BEARING HOUSING	1
6	16078	SEAL-BEARING HOUSING	1
7	23026	PULLEY-SOLID 44 TEETH	1
8	16066	NUT CLAMP-X & Y AXIS	1
9	16350	FERRULE-SPROCKET	1
11	15913	BRACKET-WAY COVER FRONT	1
13	M8-1.25X25 25B	SCREW-SHCS-STL-BO	4
14	600-5M-15	BELT-TIMING	1
15	20374	BEARING-ANGULAR CONTACT-7205 BECBP	2
16	M8 74B	WASHER-EXT TOOTH-STL-BO	4
17	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
18	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
19	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
20	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
23	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
24	1/2 70P	WASHER-FLAT USS-STL-PLAIN	2
25	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	2
28	3/16X1 1/2 81P	PIN-SPRING-STL-PLAIN	2
31	6-32X1/2 10B	SCREW-PH-PHIL-STL-BO	8
32	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
33	15616	HANDWHEEL ASSY-MX	1
34	23016	EXTENSION-BALL SCREW-Y AXIS-HANDWHEEL ASSY	1
35	1/4-20X1 3/4 25B	SCREW-SHCS-STL-BO	3
36	15614	TAB WASHER	1

i00771-Y-S5



i23158

Figure 5-25 Y Drive Train – DPME2

Y Drive Train Parts List – DPME2

Item	P/N	Description	Use As	Qty
1	15966-3	BRACKET-Y AXIS MOTOR MOUNT	EA	1
2	M10-1.5X60 25B	SCREW-SHCS-STL-BO	EA	4
3	15968-2	LOWER COVER	EA	1
4	15967-2	UPPER COVER	EA	1
5	6-32X3/8 31Z	SCREW-PH-PHIL-EXT SEMS-STL-ZINC	EA	8
7	1/2 70P	WASHER-FLAT USS-STL-PLAIN	EA	1
9	15616	HANDWHEEL ASSY-MX	EA	1
10	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	EA	1
11	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	EA	1
12	15614	TAB WASHER	EA	1
13	14772	SPACER - .100" THICK	EA	1
14	15980	BEARING HOUSING	EA	1
15	20373	BEARING-ANGULAR CONTACT- 7204 BECBP	EA	2
16	15885	RING-BEARING HOUSING	EA	1
17	15626	SEAL-BEARING HOUSING	EA	1
18	16350	FERRULE-SPROCKET	EA	1
19	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	EA	1
20	16452	NUT CLAMP-X, Y, & Z AXIS	EA	1
21	500-5M-15	TIMING BELT	EA	1
22	15627-1	DIAL HOLDER	EA	1
27	10-32X3/4 25B	SCREW-SHCS-STL-BO	EA	1
28	1/4-20X1 24B	SCREW-HEX HD-STL-BO	EA	4
29	15759	WASHER-1/4 HARD BLK OX 1/8 THK	EA	4
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2	EA	1
31	15836	DIAL NUT	EA	1
32	M5-0.8X10 10Z	SCREW-PH-PHIL-STL-ZINC	EA	2

i23158-2

5.1.11 Z-Axis Ball Screw Removal & Replacement

Refer to the following chart for illustrations and parts lists of the Z-axis drive assembly for each model.

Z-axis Drive Train		
Machine Model	Figure	Ballscrew P/N
TRM	N/A	B004
DPM	5-26	16806-m
DPM5	5-26	16806-m
Sport B3	5-26	16806-m
Sport B5	5-26	16806-m
DPMS3	5-27	16806-m
DPMS5	5-27	16806-m
DPME2	5-28	23662

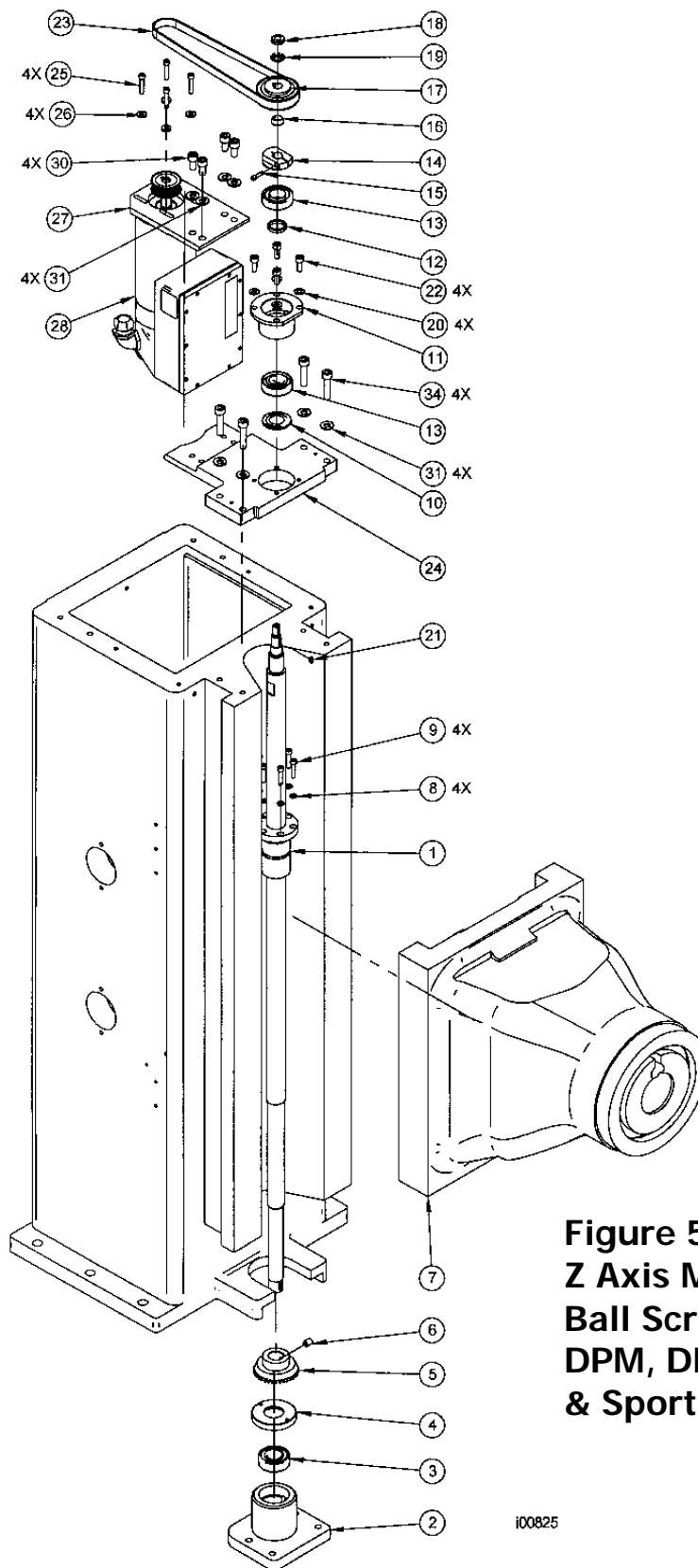
CAUTION!

Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

1. Ensure that there is sufficient vertical clearance above the top of the machine to remove the ball screw. Minimum clearance required is 32 inches.
2. Remove vertical column top cover.
3. Remove servomotor, belt and Z motor mounting bracket.
4. Remove upper and lower Z-axis way covers.
5. Lower head to table. Place 1 or 2 inch wood board between spindle nose and table to protect.
6. Lower head until weight of head is supported by the table.
7. Tighten both ram locks on the right side of ram.
8. Remove locknut and lock washer from the top of the Z ball screw.
9. Remove pulley and woodruff key.
10. Loosen #10-32 socket screw on clamp nut.
11. Using wrench flats on clamp nut and wrench flats on ball screw remove clamp nut.
12. Remove the four cap screws from bearing housing flange.
13. Remove the clamp nut.
14. Remove bearing, nilos ring and bearing housing with matched spacer from ball screw.
15. Remove (6) M6 cap screws and lock washers from ball nut flange.
16. Extract ball screw assembly from machine until ball nut flange is above the top of the ram. Support ball screw and remove lubrication line from ball nut flange.

17. Raise the ball screw until the bottom end of the ball screw is above the ram. Angle the ball screw out and away from the head. Lower the ball screw on the right side of the machine until the top of the ball screw clears the support plate.
18. Reassemble all components in reverse order as shown above, except leave off the pulley, locknut and lock washer until ball screw is realigned. Torque clamp nut to 50 ft. lb.
19. With the ball screw assembly installed, loosen four 5/16-18 cap screws from bearing housing, raise head to the uppermost position, and re-tighten 5/16-18 cap screws. Note that there is .060 clearance between the bearing housing outside diameter and the inside diameter of the support plate to allow for realignment. Traverse the head to the extreme of the up and down travel manually to check for freedom of movement. Use torque wrench to make sure torque is consistent along length of screw. Use torque wrench to make sure torque is consistent along length of screw.

See Section 5.2.2 to properly measure and set the Z Backlash Compensation and calibration.



**Figure 5-26
Z Axis Motor and
Ball Screw –
DPM, DPM5, Sport B3
& Sport B5**

100825

Parts List – Z Axis Motor and Ball Screw DPM, DPM5, Sport B3 & Sport B5

Item	P/N	Description	Use As	Qty
1	16806-M	BALL SCREW ASSY- Z-AXIS	EA	1
2	PJ540015	BRACKET LOWER ELEVATING BALL SCREW	EA	1
3	2205E-2RS1TN9	BEARING SELF ALIGNMENT SKF	EA	1
4	16774	COVER - BEARING	EA	1
5	16795	MODIFIED BEVEL GEAR BS1236-2A	EA	1
6	M10-1.5X10 40B	SCREW-SOC SET-STL-BO-CUP	EA	1
7	16770	MODIFICATION OF 3 HP RAM PING JENG PART	EA	1
8	M6 73B	WASHER-SPLIT LOCK-STL-BO	EA	6
9	M6-1.0X25 25B	SCREW-SHCS-STL-BO	EA	6
10	7205-AVH	NILOS RING-7205	EA	1
11	16295-1	HOUSING- BEARING Z-AXIS	EA	1
12	16302	RING-BEARING HOUSING	EA	1
13	20374	BEARING-ANGULAR CONTACT-7205 BECBP	EA	2
14	16773	CLAMP NUT	EA	1
15	10-32X3/4 25B	SCREW-SHCS-STL-BO	EA	1
16	16350	FERRULE-SPROCKET	EA	1
17	16983	PULLEY-SOLID 44 TEETH Z-AXIS	EA	1
18	N01	LOCKNUT	EA	1
19	W01	LOCKWASHER	EA	1
20	M8 73B	WASHER-SPLIT LOCK-STL-BO	EA	4
21	98481A090	KEY WOODRUFF #3-1/8 X 1/2	EA	1
22	M8-1.25X20 25B	SCREW-SHCS-STL-BO	EA	4
23	710-5M-15	BELT - TIMING	EA	1
24	16771	PLATE- Z AXIS SUPPORT	EA	1
25	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO	EA	4
26	15759	WASHER-1/4 HARD BLK OX 1/8 THK	EA	4
27	16772	PLATE- MOTOR- Z AXIS	EA	1
28	20328	MOTOR ASSY- HEAVY DUTY TRAK DPM	EA	1
30	M10-1.5X20 25B	SCREW-SHCS-STL-BO	EA	4
31	M10 73B	WASHER-SPLIT LOCK-STL-BO	EA	8
32	17030	LOUVER- SPACER	EA	1
34	M10-1.5X45 25B	SCREW-SHCS-STL-BO	EA	4

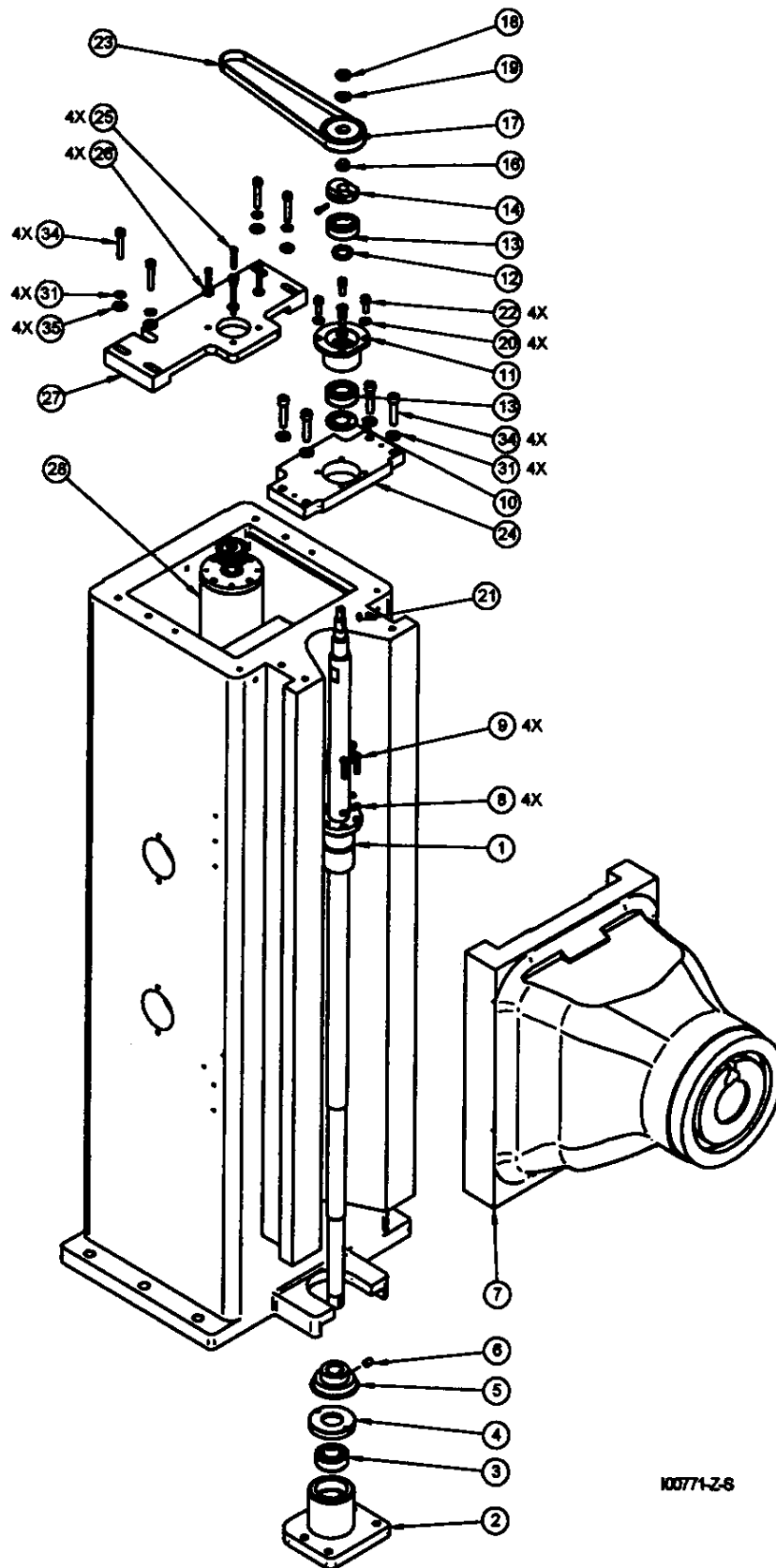


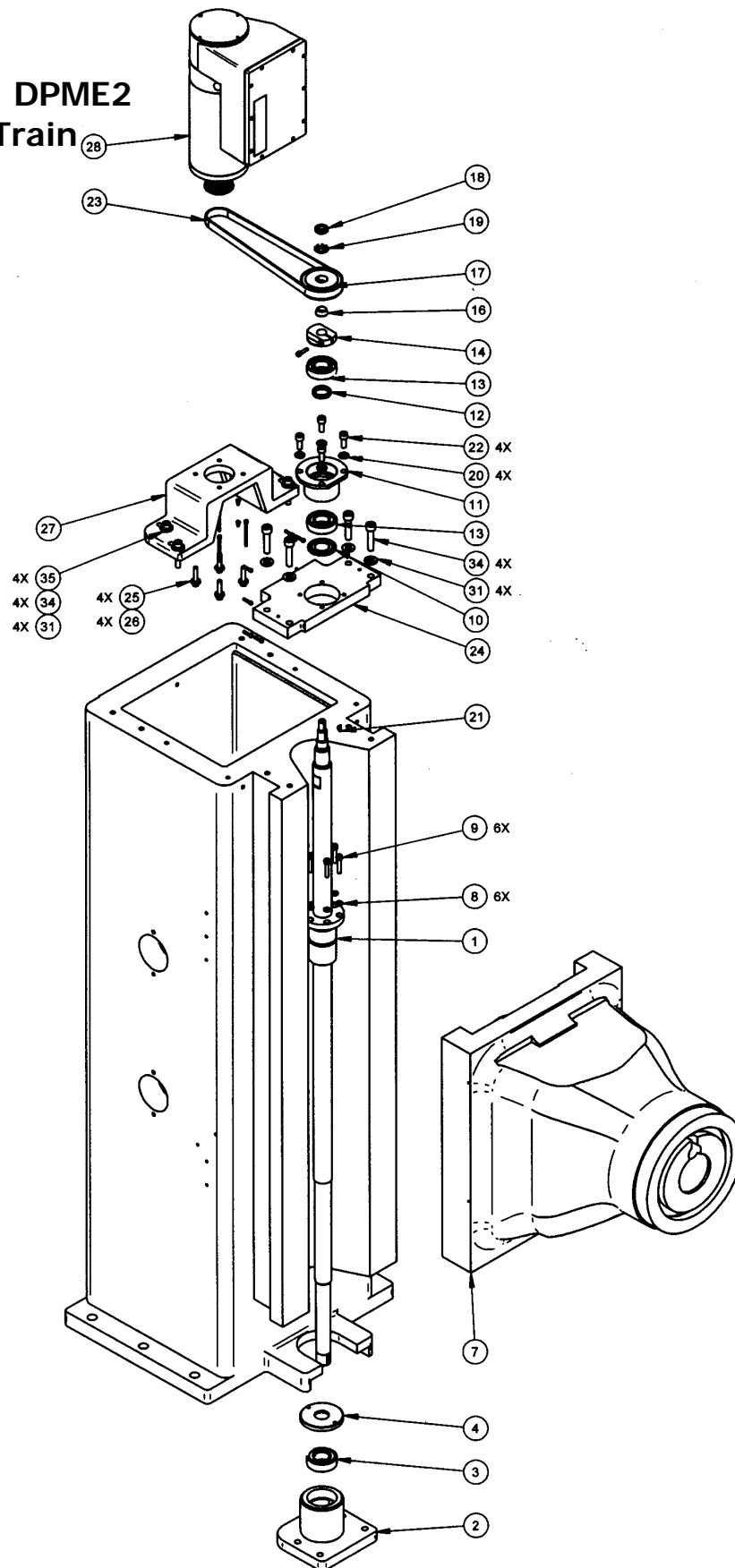
Figure 5-27 Z-Axis Drive Assembly – DPMS3/DPMS5

Z-Axis Drive Assembly Parts List – DPMS3/DPMS5

Item	P/N	Description
1	16806-M	BALL SCREW ASSY- Z-AXIS
2	PJ540015	BRACKET LOWER ELEVATING BALL SCREW
3	22583	BEARING SELF ALIGNMENT SKF 2205E-2RS1TN9
4	16774	COVER - BEARING
5	16795	MODIFIED BEVEL GEAR BS1236-2A
6	M10-1.5X10 40B	SCREW-SOC SET-STL-BO-CUP
7	16770	MODIFICATION OF 3 HP RAM PING JENG PART
8	M6 73B	WASHER-SPLIT LOCK-STL-BO
9	M6-1.0X25 25B	SCREW-SHCS-STL-BO
10	7205-AVH	NILOS RING-7205
11	16295-1	HOUSING- BEARING Z-AXIS
12	16302	RING-BEARING HOUSING
13	23940	BEARING SET-ANGULAR CONTACT-7205 BECBP
14	16773	NUT CLAMP-Z AXIS
15	10-32X3/4 25B	SCREW-SHCS-STL-BO
16	16350	FERRULE-SPROCKET
17	16983	PULLEY-SOLID 44 TEETH Z-AXIS
18	N01	LOCKNUT
19	W01	LOCKWASHER
20	M8 73B	WASHER-SPLIT LOCK-STL-BO
21	98481A090	KEY WOODRUFF #404-1/8 X 1/2
22	M8-1.25X20 25B	SCREW-SHCS-STL-BO
23	710-5M-15	BELT - TIMING
24	21944	PLATE BALL SCREW SUPPORT - Z AXIS
25	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO
26	15759	WASHER-1/4 HARD BLK OX 1/8 THK
27	23197	BRACKET-Z AXIS MOTOR-DPMS
28	23198	MOTOR DRIVER ASSY-PT4-DPM-SM-4050
31	M10 73B	WASHER-SPLIT LOCK-STL-BO
32	17030	LOUVER- SPACER
34	M10-1.5X45 25B	SCREW-SHCS-STL-BO
35	M10 71B	WASHER-FLAT SAE-STL-BO
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2

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**Figure 5-28 DPME2
Z-Axis Drive Train**



116790-XXX

Z-Axis Drive Train Parts List – DPME2

Item	P/N	Description	Qty
1	23662	BALL SCREW ASSY- Z-AXIS - LM0010	1
2	23658	BRACKET LOWER ELEVATING BALL SCREW - SW0008	1
3	2205E-2RS1TN9	BEARING SELF ALIGNMENT SKF	1
4	16774	COVER - BEARING-SW00007	1
5			
6			
7	16770	MODIFICATION OF 3 HP RAM PING JENG PART	1
8	M6 73B	WASHER-SPLIT LOCK-STL-BO	6
9	M6-1.0X25 25B	SCREW-SHCS-STL-BO	6
10	7205-AVH	NILOS RING-7205	1
11	16295-1	HOUSING- BEARING Z-AXIS	1
12	16302	RING-BEARING HOUSING	1
13	20374	BEARING-ANGULAR CONTACT-7205 BECBP	2
14	16773	NUT CLAMP-Z AXIS	1
15	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
16	16350	FERRULE-SPROCKET	1
17	16983	PULLEY-SOLID 44 TEETH Z-AXIS	1
18	N01	LOCKNUT	1
19	W01	LOCKWASHER	1
20	M8 73B	WASHER-SPLIT LOCK-STL-BO	4
21	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
22	M8-1.25X20 25B	SCREW-SHCS-STL-BO	4
23	710-5M-15	BELT - TIMING	1
24	23664	PLATE BALL SCREW SUPPORT - Z AXIS - LM0011	1
25	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO	4
26	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
27	23655	BRACKET-Z AXIS MOTOR-DPME2	1
28	23198	MOTOR DRIVER ASSY-PT4-DPM-SM-4050	1
31	M10 73B	WASHER-SPLIT LOCK-STL-BO	8
32	17030	LOUVER- SPACER	1
34	M10-1.5X45 25B	SCREW-SHCS-STL-BO	8
35	M10 71B	WASHER-FLAT SAE-STL-BO	4
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5.1.12 Air Solenoid Replacement for Power Drawbar – DPMS3/DPMS5 only

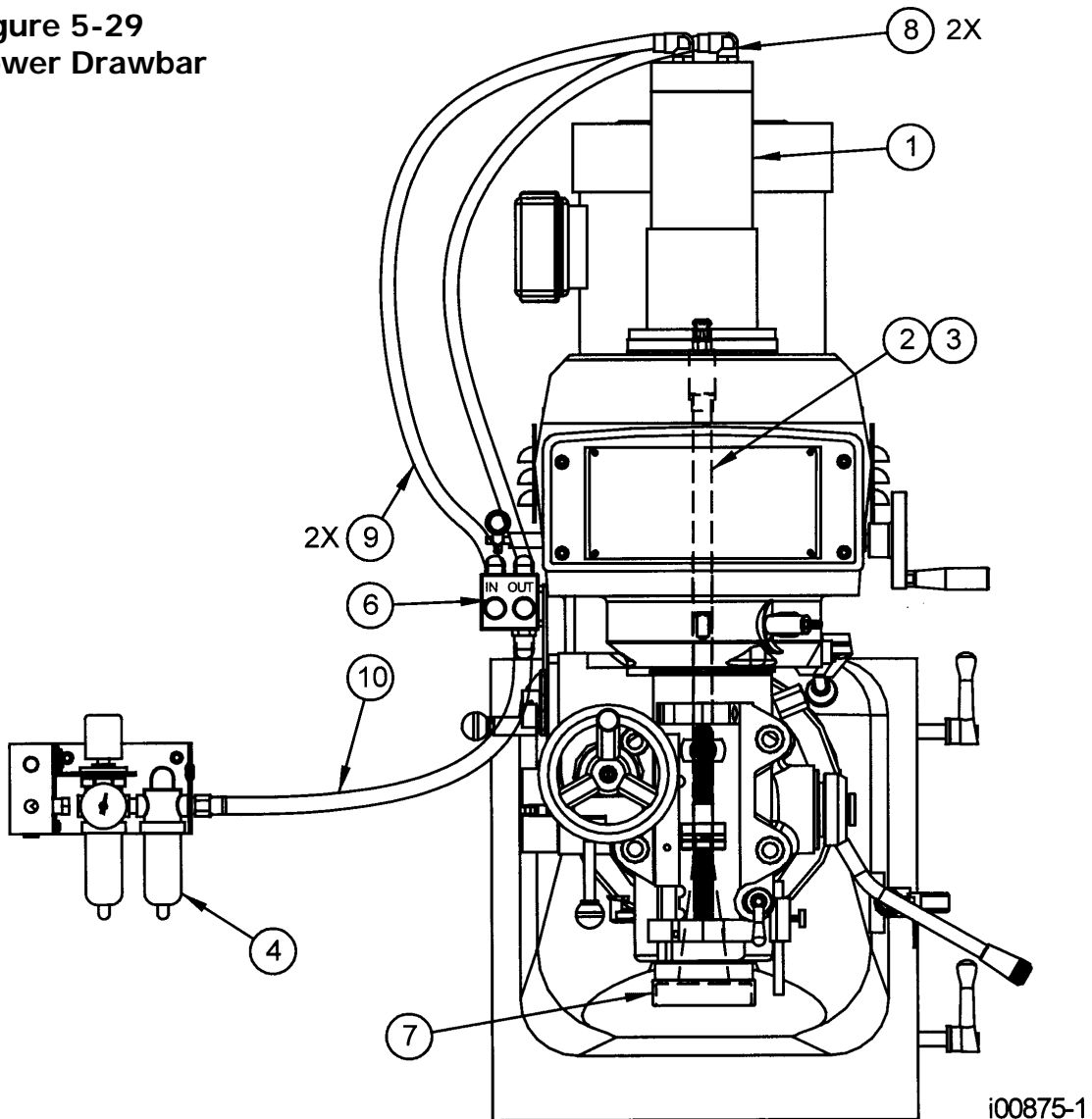
1. Unhook the air from the machine.
2. Unplug the power cable that connects to the right side of the air regulator bracket.
3. Remove the 2 screws that hold the connector to the bracket.
4. Undo the airline that runs from the oiler to the power drawbar if that option is installed on the machine.
5. Remove the 2 screws on the left side of the bracket that holds the air manifold to the U-shaped bracket.
6. With the assembly in hand, unthread the solenoid from the rear of the air
7. regulator. The solenoid and cable will be replaced as a unit.

Power Drawbar Parts List

Item	P/N	Title
1	22581-1	AIR GUN ASSY ONLY- TORQUE RITE
2	22603-NST	DRAWBAR-DPMS3
3	20893	TOP WASHER
4	22380-2	AIR REGULATOR ASSY
5	22603-CAT	DRAWBAR-DPMS3
6	22581-2	SWITCH - CONTROL HEAD - TORQUE RITE
7	22581-4	NOSEPIECE FOR SPINDLE
8		1/4" NPT AIR FITTING 90°
9		3/8 O.D. TUBING 132" LG.
10		3/8 O.D. TUBING 27" LG.
11	22641-NMTB	DRAWBAR-DPMS5
12	22641-CAT	DRAWBAR-DPMS5

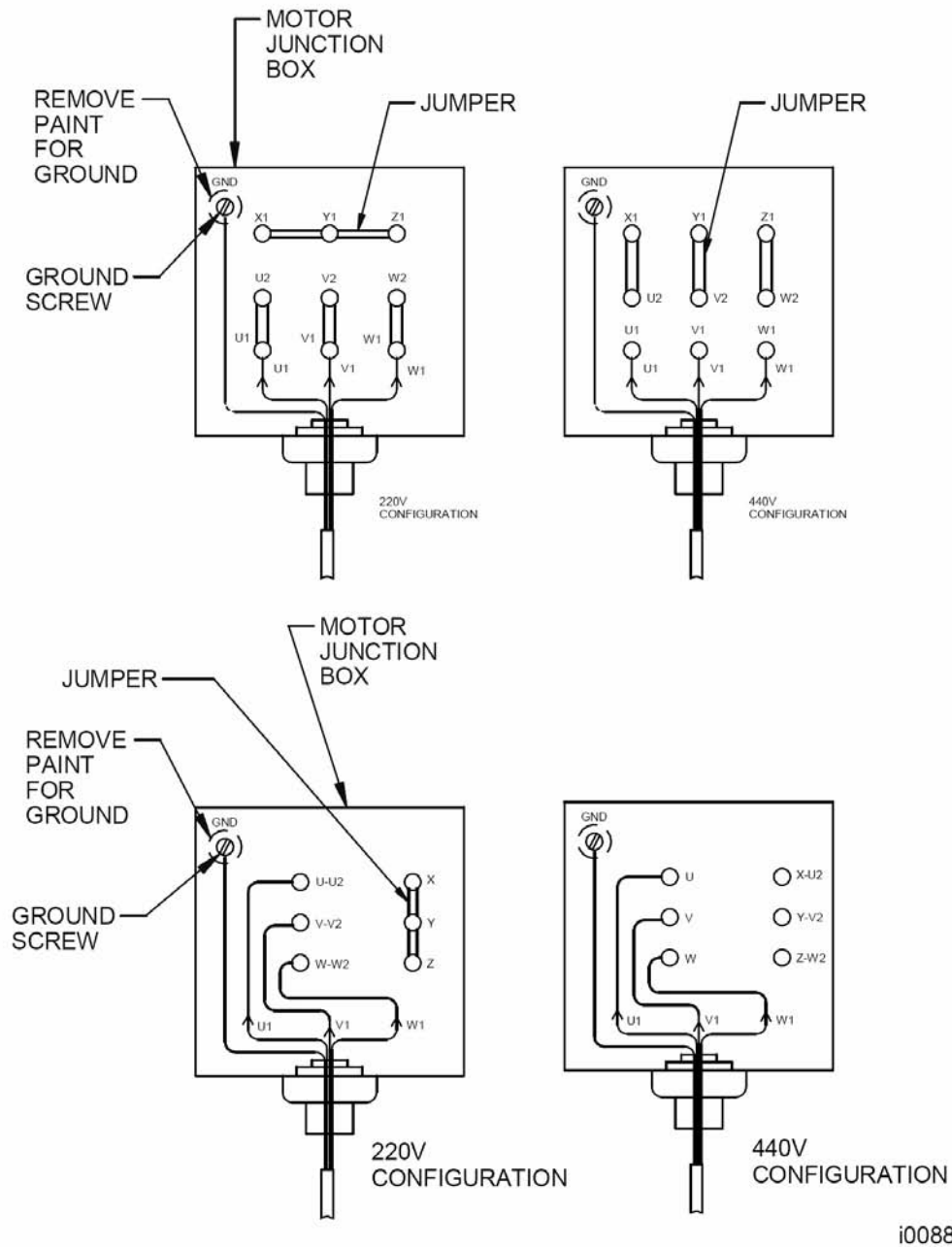
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Figure 5-29
Power Drawbar



5.1.13 Spindle Motor Wiring

All bed mill spindle motors are wired for 220 or 440 volts except the DPME2, which is wired for 220 volts only. See Figure 5-29 for how to wire all motors with exception to model DPME2. See Figure 5-30 for how to wire the spindle control motor for DPME2



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Figure 5-30
Spindle Motor Wiring (except DPME2)

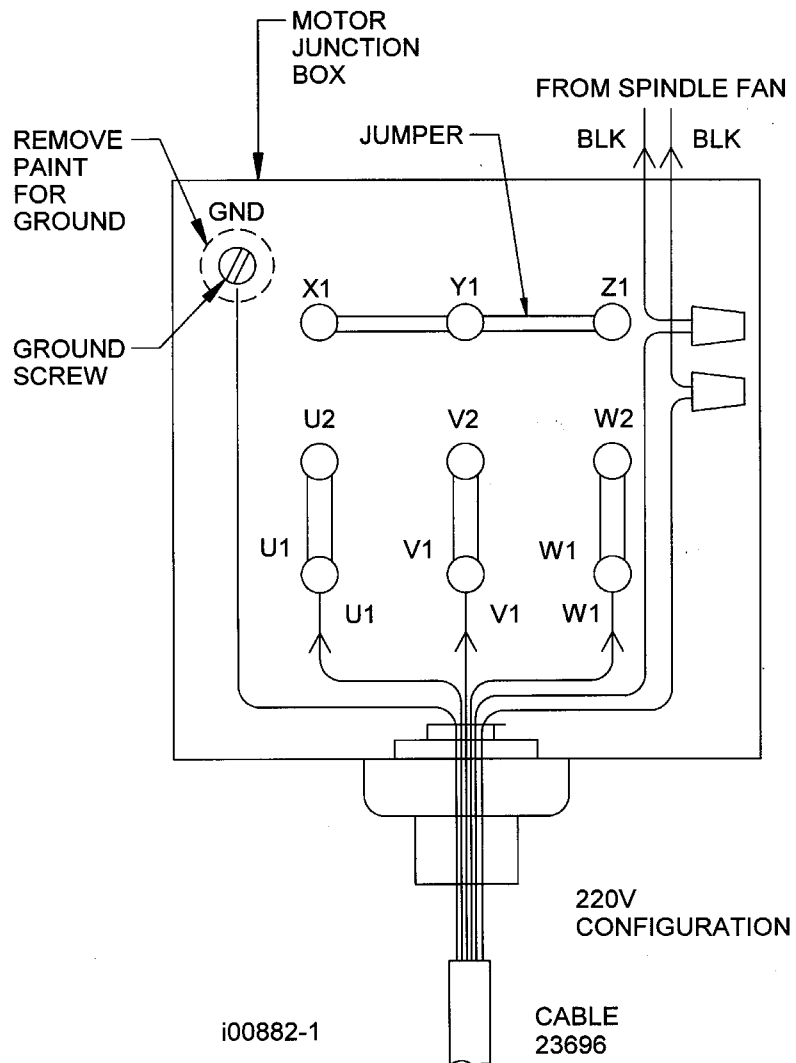


Figure 5-31

Spindle Motor Wiring – Spindle Control – DPME2 only

5.1.14 Electric Box Service – TRM (P/N 20655-220 or 20655-440), DPM & DPM5 only (P/N 17009-220 or 17009-440)

The electric box contains a relay module, which comprises all electrics for the machine and control (relays, contacts, fuses, etc.). Figure 2-15 in Section 2 shows the electrical diagram for the relay module. Refer to Section 5.1.15 for Auxiliary Function Interface (DPM/DPM5 only).

The entire relay module may easily be exchanged or replaced with the following procedure.

DANGER!

Always disconnect the 220V/440V, 3-phase input and the 15-VAC input before opening the electrics box.

1. Unplug all plugs connected to the relay module located on the side of the electrics box.
2. Unscrew the two Philips head screws on the clamps that hold the electrics box door shut. Open the electrics box door. The door interlock must be in the **Off** position to open.
3. Disconnect the 3-phase into the relay module and the 3-phase out to the spindle motor (see Figure 2-15).
4. Unscrew the 21 black Philip head screws on the side of the electrics box, and the 2 black Philips head screws inside the electrics box that connect the relay module to the electrics box. The entire relay module can now slide out of the electrics box.

5.1.14.1 Fuses

The fuse identification is shown on the relay module label. Use only the correct fuses.

5.1.14.2 Red LED Diagnostic Status Indicators

There are 12 red LED diagnostic status indicators located on the right side of the relay module.

The meaning of these LED's is as follows (LED 1 is on the top):

1. LED 1 is on when the pendant is switched on. LED 1 also indicates that the computer module is receiving 115 VAC.
2. LED 2 is on when the E-Stop on the switch box is in the *Out* position and the overload relay has not been tripped. LED 2 is on during normal operation.
3. LED 3 is on when the switch box is receiving 115 VAC. LED 3 is on during normal operation.
4. LED 4 is on when the spindle switch on the switch box is in the 1 or 2 position and the spindle is on.

5. LED 5 is on when the coolant pump is on. The coolant pump can be turned on either by the switch box or via a CNC auxiliary function (see Section 5.1.15). (DPM only)
6. LED 6 is on when the overload relay is tripped. LED 6 is off during normal operation.
7. LED 7 is on when the E-Stop on the switch box is in the *Out* position. LED 7 is on during normal operation.
8. LED 8 flashes on when the Haas rotary table is being indexed one cycle or step. The function is controlled through Auxiliary Function 3 (see Section 5.1.15). (DPM only)
9. LED 9 flashes on when the Haas rotary table has completed indexing one cycle or step. (DPM only)
10. LED 10 is on when Auxiliary Function 1 (coolant pump) is on (see Section 5.1.15). (DPM only)
11. LED 11 is on when Auxiliary Function 2 (air relay) is on (see Section 5.1.15). (DPM only)
12. LED 12 is on when Auxiliary function (spindle motor) is on (see Section 5.1.15). (DPM only)

5.1.15 Auxiliary Function Interface (DPM/DPM-5 only)

Refer to the machine programming, operating, and care manual for the procedures to use the auxiliary functions.

AUX FUNCTION 1 – A/C Relay. Auxiliary Function 1 turns power to 115V A/C (2 amp) socket on and off. The socket is located on the side of the Electrics Box. Power to this socket can also be controlled by the Coolant Switch on the front panel of the Switch Box. The 115V is turned on when either the programming AUX 1 is activated, or when the Switch Box switch is turned to the *On* position. The most common use for this function is the coolant pump, but other A/C driver devices may be substituted (for example, a light).

AUX FUNCTION 2 – Air Relay. Auxiliary Function 2 turns shop air on and off. Shop air "in" is connected through the bracket on the back of the column. The fitting is ready to accept a standard quick disconnect device with a 1/4 inch pipe thread. Air pressure is not to exceed 100 psi.

Shop air "out" is at the "Pneumatic Device Out" port. Connect the plastic tubing supplied in the hardware kit. The most common use for this function is for a spray mister. Lube and water separators are recommended. (Minimum 24" from DPM.)

AUX FUNCTION 3 – Rotary Indexer. Auxiliary Function 3 transmits an electronic signal to be used by a relay or another electronically driven device. It also transmits input back from the device to restart the program. The most common use is a Haas type rotary indexer.

The signal output is a 0.3 second activation of a solid-state relay between Pins 3 and 4. The maximum permissible voltage is 60 VDC or 40 VAC with a maximum current of .025 amps.

The input is a 0.1 second or greater activation of the external device (indexer) relay between Pins 1 and 2. The relay impedance must be less than 500 ohms.

The connector for this output is located on the side of the Electrics Box and is labeled "Logic To Indexer." On this connector Pin 1 is on the bottom, Pin 2 is on the left, Pin 3 is on the right, and Pin 4 is on the top.

Included in the hardware kit is a cable with a connector for the Electrics Box and a Haas Indexer.

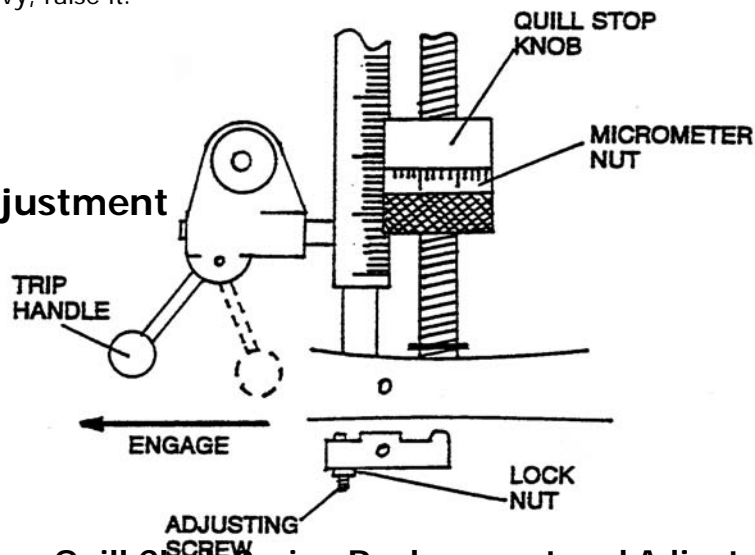
AUX FUNCTION 4 – Spindle Motor. Auxiliary Function 4 turns the spindle motor off at a tool change and at the end of the part program. This capability is designed into the DPM & DPM5.

5.1.16 Feed Trip Adjustment – All bed mills except DPME2

If the feed trip is adjusted too light it will inadvertently trip when drilling. If too heavy, it will not trip accurately and stress the mechanism. The correct adjustment depends on the operation to be performed. To adjust:

1. Release the lock nut.
2. Engage the trip handle--move it left.
3. Adjust the micrometer nut against the quill stop knob.
4. Slowly turn the adjusting screw until the handle trips.
5. Tighten the lock nut.
6. Check the reaction. If too sensitive, lower the adjusting screw slightly. If too heavy, raise it.

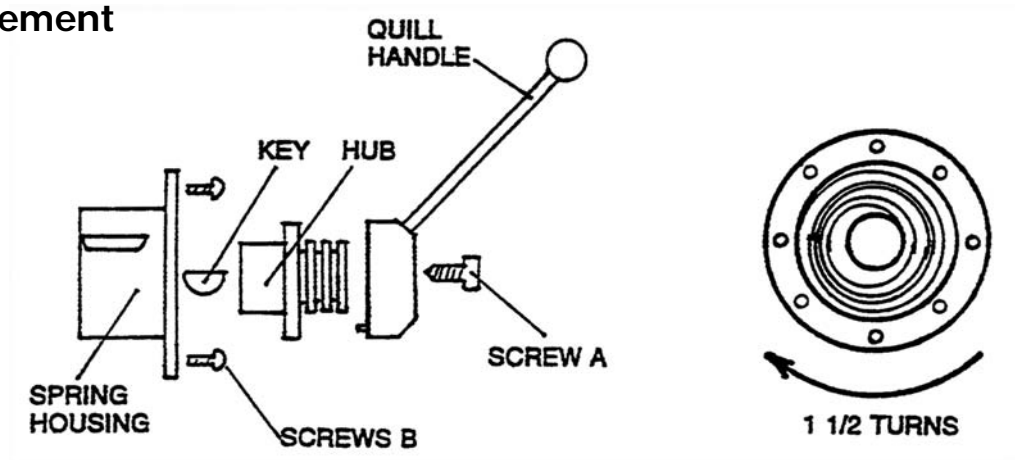
Figure 5-32
Feed Trip Adjustment



5.1.17 Quill Clock Spring Replacement and Adjustment

The quill Clock Spring counterbalances the weight of the quill and tool.

Figure 5-33
Quill Clock Spring
Replacement



1. Move the quill to its top position and lock it in place.
2. Remove the quill handle, hub (by removing Screw A) and key.
3. Remove Screws B and allow the spring housing to unwind.
4. Remove the spring. It is held by a pin on the shaft and slot in the housing.
5. Replace the spring. Rotate the housing clockwise until the spring catches the shaft pin.
6. Rotate (wind up) the housing 1 1/2 turns, replace Screws B, key hub, Screw A, and handle.

5.1.18 Spindle Motor Removal and Replacement

5.1.18.1 TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3 & DPMS5

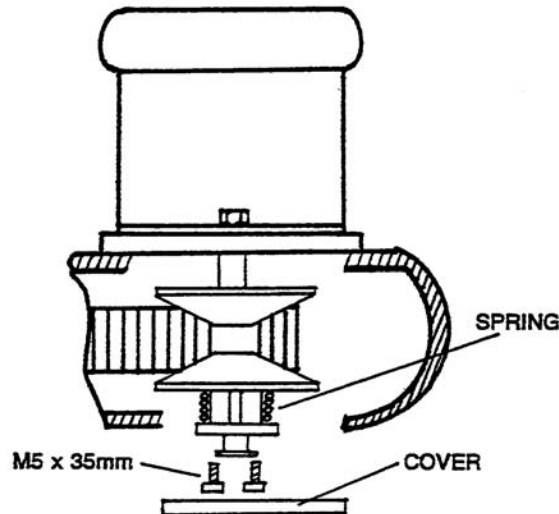
CAUTION!

The motor is heavy--about 60 pounds. Be certain you have the proper equipment or assistance.

1. While the spindle is running, change the RPM to its lowest value.
2. Disconnect the power to the motor. It is recommended that the power disconnect be made from the shop feeder box.
3. Disconnect the electrical connection in the conduit box attached to the motor.
4. Crank the speed changer to the highest RPM value.
5. Remove the two screws that fasten the motor to the top of the housing.

6. Tilt the motor forward and remove the belt from the motor pulley. Remove the motor.
7. If the motor is to be replaced, remove the M8 socket head cap screw at the end of the motor shaft. Slide the pulley assembly off the motor shaft and onto the new motor.

**Figure 5-34
Spindle Motor**



I00155

5.1.18.2 Spindle Motor Removal & Replacement – Spindle Control DPME2 only (refer to Figure 5-34, Item 1 & Figure 6-21, Item 26)

1. Disconnect the power to the motor. It is recommended that the power disconnect be made from the shop feeder box.
2. Disconnect the electrical connection in the conduit box attached to the motor.
3. Remove the three bolts that hold the motor pulley cover in place to gain access to the belt.
4. Remove the four bolts that mount the motor to the top head housing.

CAUTION!

The motor is heavy--about 60 pounds. Be certain you have the proper equipment or assistance.

6. Loosen the ½" nut on the belt tensioner puller screw at the back of the motor. Release the belt tension using a #6 hex key to unscrew the tensioner puller screw from the motor housing.
7. Tilt the motor towards the back and remove the belt from the motor pulley. Remove the motor.
8. If the motor is to be replaced, remove pulley assembly off the motor shaft and onto the new motor.

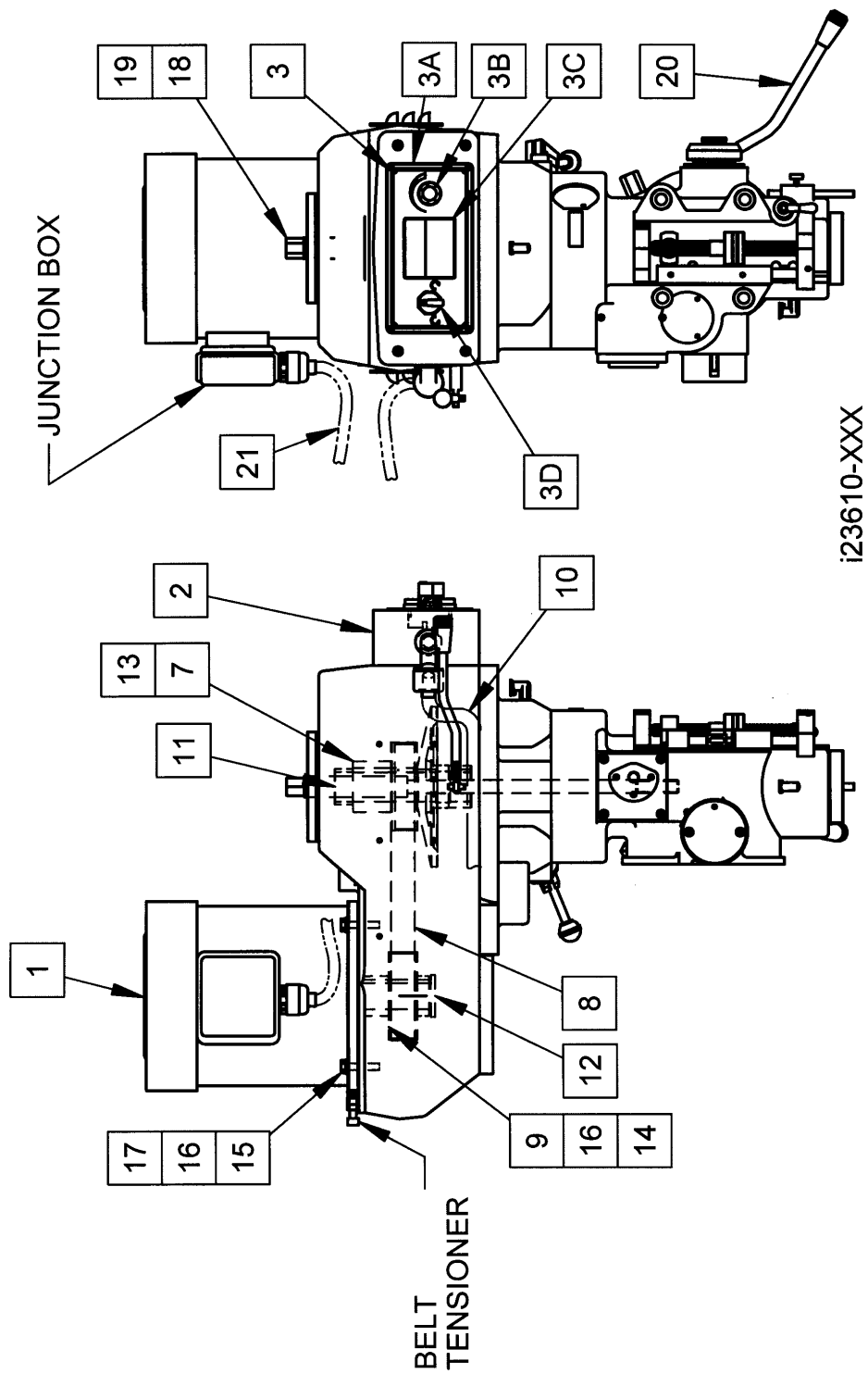


Figure 5-34 DPME2

DPME2 - Spindle Head Parts List

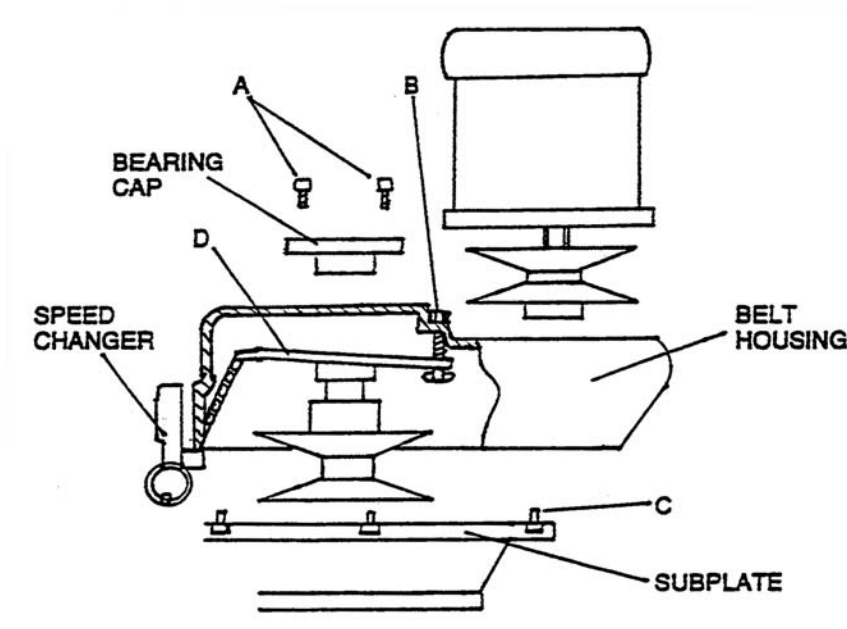
Item	P/N	Description	Qty
1	23585	MOTOR-3 HP/3 PH-1725 RPM-220 VOLTS	1
2	23629	CONTROL BOX-HEAD-DPME	1
3	23698	WIRING ASSY-SPINDLE HEAD-DPME-CONTROL BOX TO SWITCHES	1
3A	23621	NAMEPLATE-DPME-SPINDLE HEAD	1
3B	23624	POTENTIOMETER	1
3C	23623	TACHOMETER-RPM 0-5000 HIGH/0-600 LOW	1
3D	23628	FWD/REV SWITCH	1
3E	22125-03	SLEEVE- SHRINKABLE TUBING	3 IN
3F	21953-18	TERMINAL- RING TONGUE	2
3G	22404-18	TERMINAL- WIRE PIDG FORK	8
3H	22285-YL-20G	WIRE- UL1007	118 IN
3J	22475	TIE WRAP-4 IN-PLASTIC	1
7	23632	SPINDLE PULLEY-117 mm	1
8	23597	BELT-MICRO-V-J PROFILE 10 RIBS "J"	1
9	23631	MOTOR PULLEY-117 mm-DPME	1
10	23695	HARNESS ASSY-SPINDLE CONTROL-DPME-ELECTRIC BOX TO SWITCHES	1
11	23573	SPACER-SPINDLE SHAFT BUSHING-DPME	1
12	23574	PLATE RETAINER-SPINDLE SHAFT-DPME	1
13	23755	KEY-8 mm x 8 mm	1
14	23756	KEY-10 mm x 10 mm	1
15	M8 70B	WASHER-FLAT USS-STL-BO	4
16	M8 73B	WASHER-SPLIT LOCK-STL-BO	4
17	M8-1.25X40 24B	SCREW-HEX HEAD-STL-BO	4
18	VS109	FRU-K3-DRAWBAR 7/16-20UNF	1
19	VS109-1	SPACER-DRAWBAR	1
20	20849	QUILL HANDLE	1
21	23696	HARNESS ASSY-SPINDLE MOTOR-DPME2	1

i23610-XXX

5.1.19 Drive Belt Replacement

5.1.19.1 TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3 & DPMS5

1. Remove the motor.
2. Remove the draw bar and its bushing.
3. Remove the three Screws A and use M6 x 35mm screws in the adjacent tapped holes to remove the Bearing Cap.
4. Remove the nut from the fine speed adjustment Screw B and turn the screw all the way down through the casting. Catch it from the motor hole.
5. Remove six Screws C holding the belt housing to the subplate.
6. Remove the four screws holding the speed changer.
7. Remove the belt housing.
8. Replace the belt by sliding it over the speed changer.
9. In reassembly be certain the fine speed adjustment Screw B goes into the slot of the Speed Change Plate D in the area in which the screw is not threaded.



i00156

Figure 5-35
Drive Belt Replacement

5.1.19.2 Drive Belt Replacement for Spindle Control - DPME2

1. Remove the draw bar and its bushing (remove power drawbar if present).
2. Remove the three Screws A and use M6 x 35mm screws in the adjacent tapped holes to remove the Bearing Cap.
3. Follow instructions for spindle motor removal and remove motor so top head housing can be removed with ease.
4. Remove the six screws "C" that hold the belt housing to the subplate.
5. Disconnect the spindle control harness at the head control box.
6. Lift off the belt housing; then remove belt.

5.1.20 Timing Belt Replacement

1. Remove the motor and drive belt.
2. Slide the top or adjustable varidisc pulley assembly off the shaft.
3. Remove the three M8 screws holding the belt housing base to the gear housing.
4. Lower the quill about 4 inches.
5. Remove the belt housing base and lower or stationary varidisc pulley assembly.
6. Replace the timing belt.

5.1.21 Brake Shoe Replacement

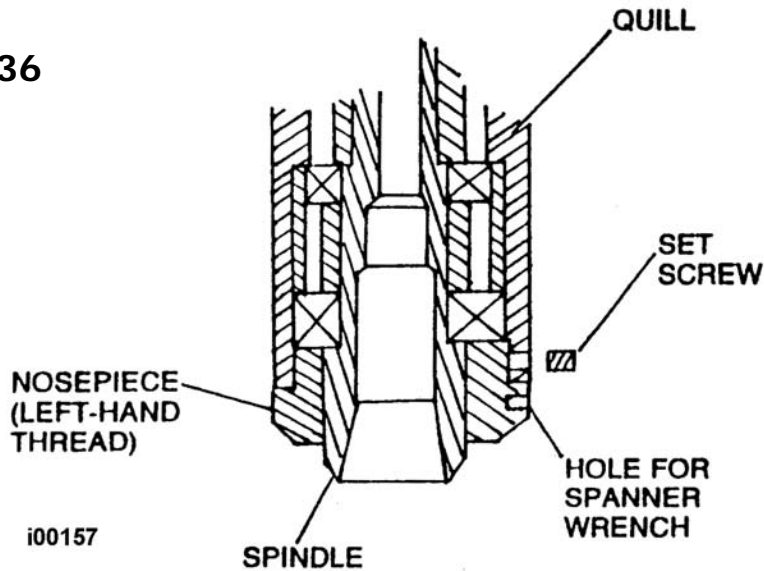
1. Remove the motor, drive belt and complete Steps 1-5 of the timing belt replacement procedure.
2. Remove the two M6 cap screws from the bottom of the belt housing base.
3. Separate the belt housing base from the lower or stationary varidisc pulley. This is a slight press fit.
4. Remove the 2 springs.
5. Replace the brake shoes.

5.1.22 Spindle Replacement

1. Remove the draw bar and its bushing.
2. Lower the quill about 1 inch and lock.

3. Remove the setscrew from the back of the spindle.
4. Loosen (unscrew) the large black ring (nosepiece) with a spanner wrench.
Note: The nosepiece has a left hand thread-- rotate counterclockwise to loosen.
5. Using a soft bar about 12 inches long, alternately tap on the top of the spindle and loosen a few threads on the nosepiece until fully unscrewed (the nosepiece will remain attached to the spindle).
6. Continue to tap the spindle out of the quill. The spindle bearings will come out with the spindle.

Figure 5-36



5.2 Maintenance

5.2.1 Gib Adjustments

The objective of adjusting the gibs is to eliminate as much play in the table, saddle and ram sliding surfaces as possible without having the tightness of the gib interfere with their free movement and cause a decrease in the accuracy and/or performance of the machine due to excessive friction.

5.2.1.1 Table Gib Adjustment, X-Axis

5.2.1.1.1 TRM, DPM, Sport B3, DPMS3, DPME2

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.

Note: For machines that have excessive wear in the center of the table way, it will be necessary to center the table on the saddle. The resulting adjustment of the

gib will be compromised to account for the varying clearance from the center to the ends of the table.

4. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the front surface of the table as close to the indicator base as possible.

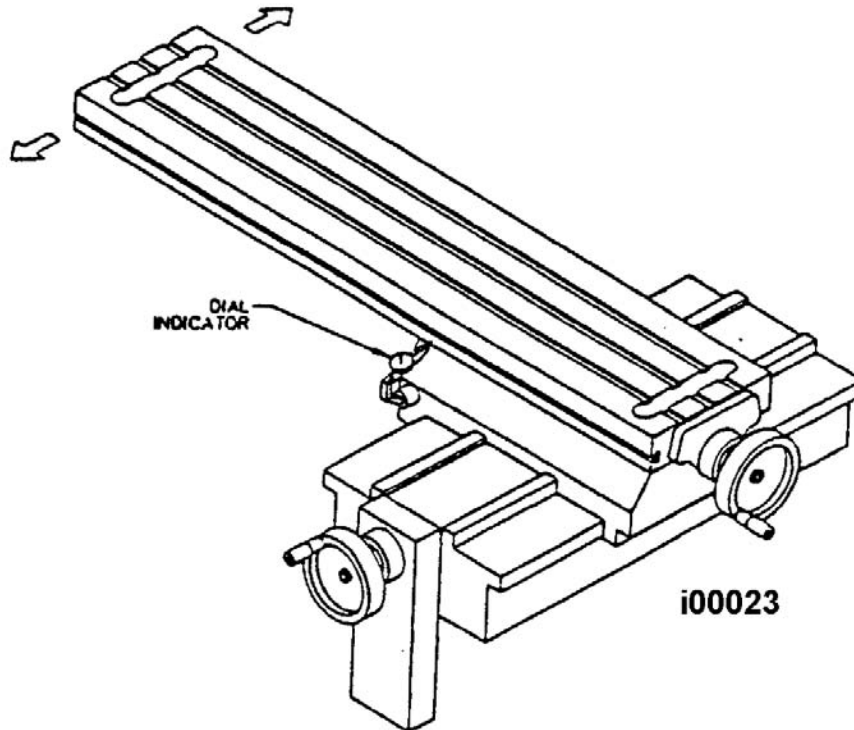


Figure 5-37 – Table Gib Adjustment

5. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the X-axis gib until the registered movement is .0010-.0015.
 - To adjust the gib for excessive clearance: Loosen the gib lock screw on the right end of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the left end of the saddle. Tighten the gib lock screw on the right end of the saddle to lock the give in place, and recheck. Repeat as necessary.
 - To adjust the gib for too small of a clearance: Loosen the gib lock screw on the left end of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the right end of the saddle. Tighten the gib lock screw on the left end of the saddle to lock the gib in place, and recheck. Repeat as necessary.
6. Center the table on the saddle and run Service Code 12 to set the Feed Forward Constant

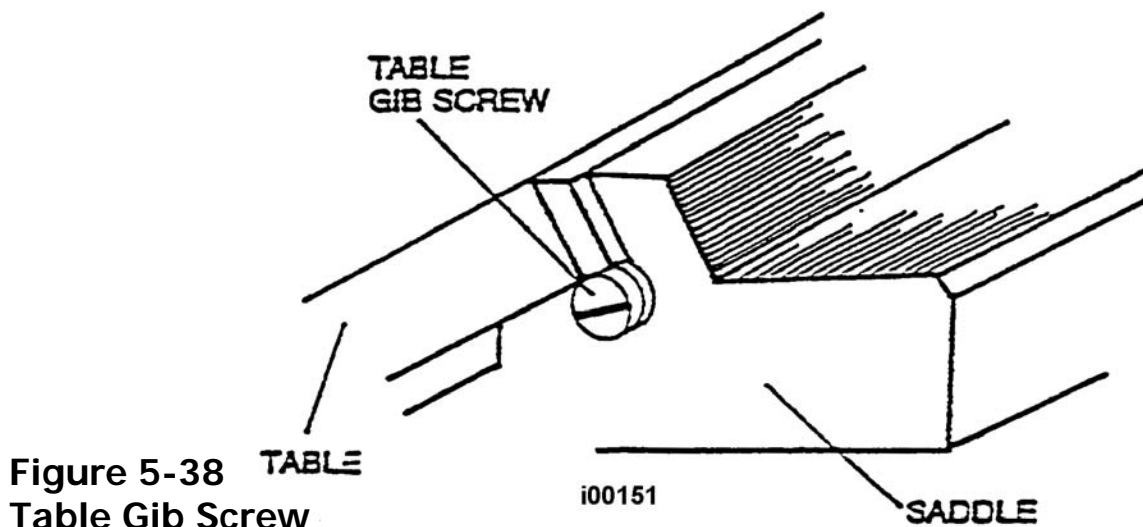


Figure 5-38 TABLE
Table Gib Screw

5.2.1.1.2 DPM5, Sport B5, DPMS5

The X-axis has 2 gibs for the table because of the length of the saddle. Each gib is adjusted from each end of the table. There are not 2 adjustment screws at either end of the gib like the Y-axis and Z-axis.

Clean all chips, dirt and excess oil from the table.

Remove the table trays.

1. Move the table to the left and mount the indicator at Point D and move the table back and forth. Note the amount of movement of the dial indicator. Adjust gib until the movement is between .0005-.001.
2. Move the table to the right and mount the indicator at Point A and move the table back and forth. Note the amount of movement of the dial indicator. Adjust gib until the movement is between .0005-.001.
 - To adjust the gib for excess clearance: Loosen the nut closest to the table and tighten the nut furthest from the table. Once the clearance has been taken up tighten each nut against the gib bracket. Do this for each end of the table.
 - To adjust the gib for too small of a clearance: Loosen the nut furthest from the table and tighten the inside nut up against the bracket to pull the gib away from the machine. Once the clearance has been taken up tighten each nut against the gib bracket. Do this for each end of the table.
3. Center the table on the saddle and run Service Code 12 to set the Feed Forward Constant
4. Replace the table trays. See Figure 5-39.

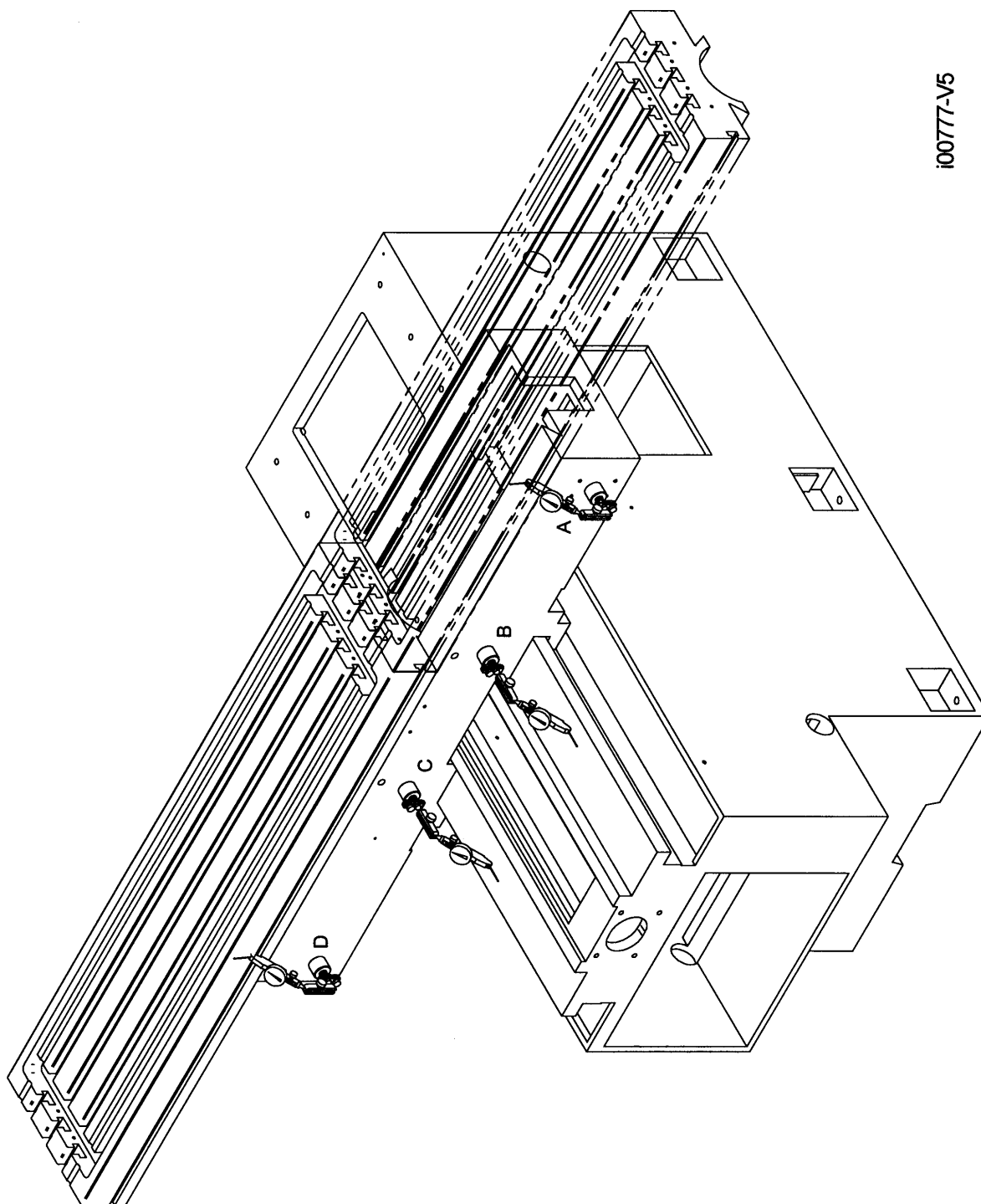


Figure 5-39
DPMS5 Table Gib & Saddle Bottom Gib Adjustment

5.2.1.2 Saddle Side Gib Adjustment, Y-Axis – All machines

See Figure 5-40

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.
4. Remove the chip wiper guard and chip wiper from the front and rear of the left side box way.

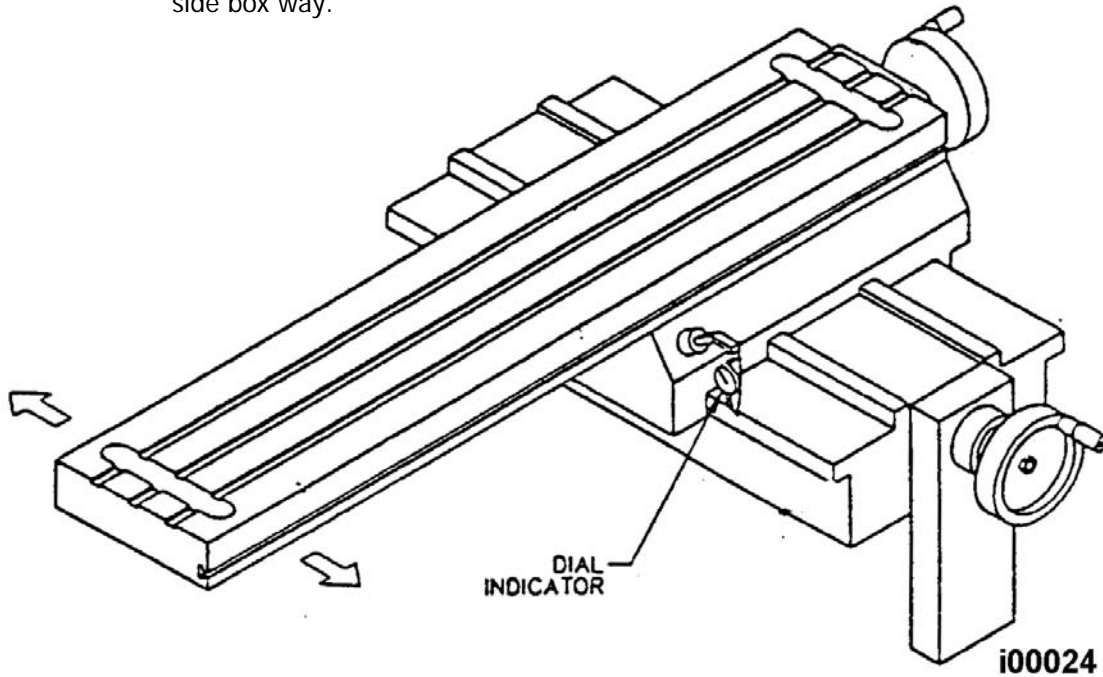


Figure 5-40
Saddle Side Gib Adjustment

5. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the edge of the large box way.
6. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the Y-axis side gib until the registered movement is .0010-.0015.
 - **To adjust the gib for excessive clearance:**
Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary
 - **To adjust the gib for too small of a clearance:**
Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.

7. Replace the front and rear chip wiper, and chip wiper guard.
8. Center the table on the saddle and run Service Code 12 to set the Feed Forward Constant.

5.2.1.3 *Saddle Bottom Gib Adjustment, Y-Axis*

5.2.1.3.1 *TRM, DPM, Sport B3, DPMS3*

See Figure 5-41.

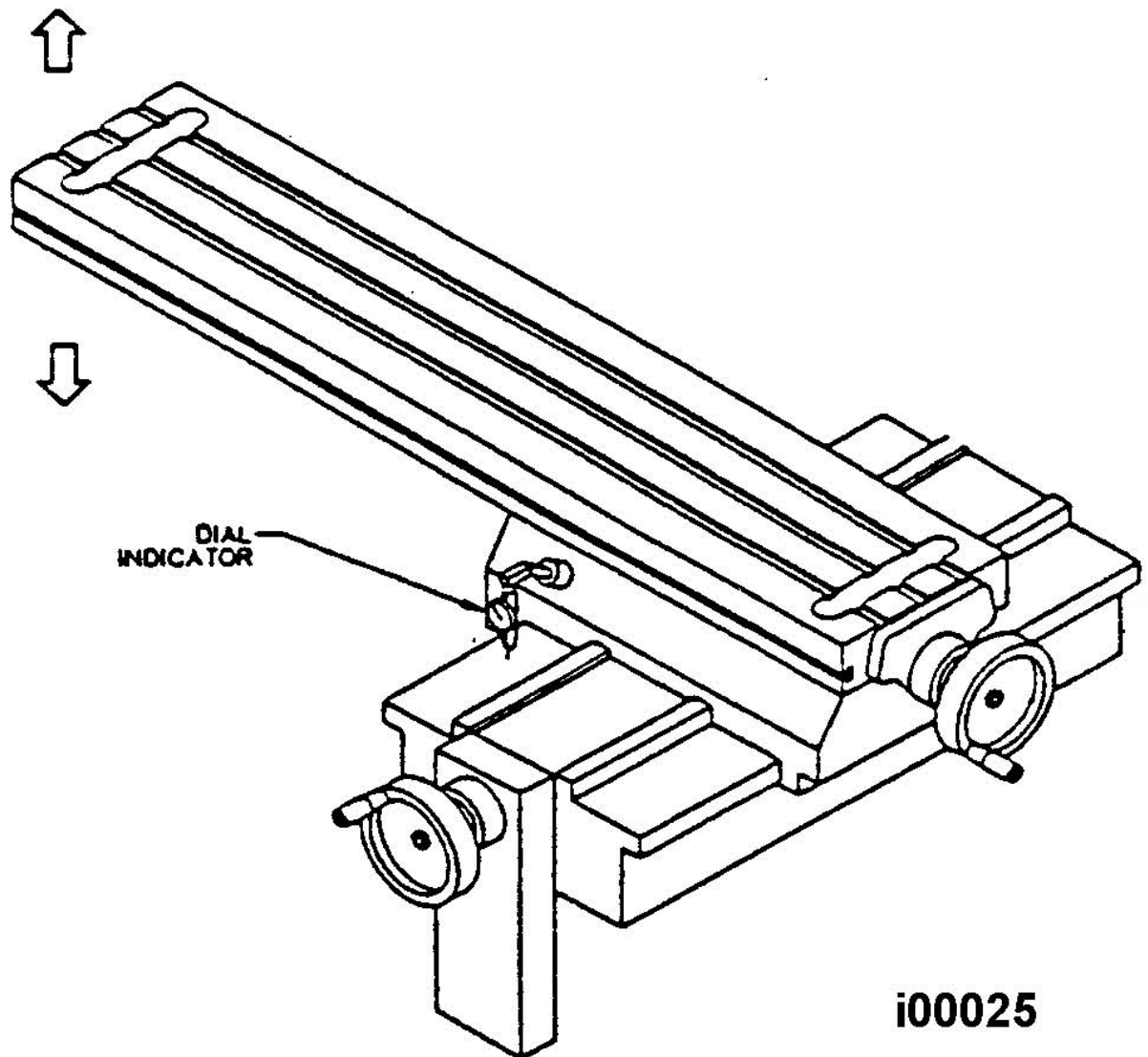
1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.
4. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the top surface of the box way.
5. Lift the end of the table up and note the amount of movement on the dial indicator. Adjust the Y-axis left bottom gib until the registered movement is .0010-.0015.
6. Move the table fully to the right.
7. Reposition the indicator to the right front of the saddle.
8. Lift the right end of the table up and note the amount of movement on the dial indicator. Adjust the Y-axis right bottom gib until the registered movement is .0010-.0015.

- **To adjust the gib for excessive clearance:**

Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary.

- **To adjust the gib for too small of a clearance:**

Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.



**Figure 5-41 Saddle Bottom Gib Adjustment –
TRM, DPM, Sport B3, DPMS3**

5.2.1.3.2 DPM5, Sport B5, DPMS5

It is unrealistic to adjust the Y bottom ways the same way as we do on the lighter mills because of the extra weight of the saddle and table.

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Mount your indicator on the left side of the saddle (Point C) with the table in the center of its travel and zero out your indicator.
4. Move the table all the way to the right side. When the gibs are adjusted properly you should see no more than 0.0003" movement on the indicator.
5. Do the same thing on the right side of the saddle (Point B) this time moving the table all the way to the left. The reading should be positive on the indicator because the saddle should rise where you are indicating.

Note: You can get better readings than 0.0003" but the torque on the Y ball screw may exceed our recommended levels. Remove the ball screw cover and check the torque with an in-lb torque wrench. Normally, the torque should be around 15 in-lbs. Do not exceed 20 in-lbs. Values higher than this may cause circularity problems.

See Figure 5-41 for an illustration.

- **To adjust the gib for excessive clearance:**
Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary.
- **To adjust the gib for too small of a clearance:**
Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.

5.2.1.4 Ram Back Gib Adjustment - Z Axis – All Machines

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Disconnect one end of the upper and lower way cover where it is attached to the ram.
3. Position the milling head such that the table can be reached by extending the quill approximately 3/4 of its travel.
4. Place a wood block on the table underneath the spindle.
5. Attach a .0001 dial indicator with a magnetic base to the column near the base of the ram on the left side of the machine. Place the indicator stylus on the rear surface of the ram near the bottom.

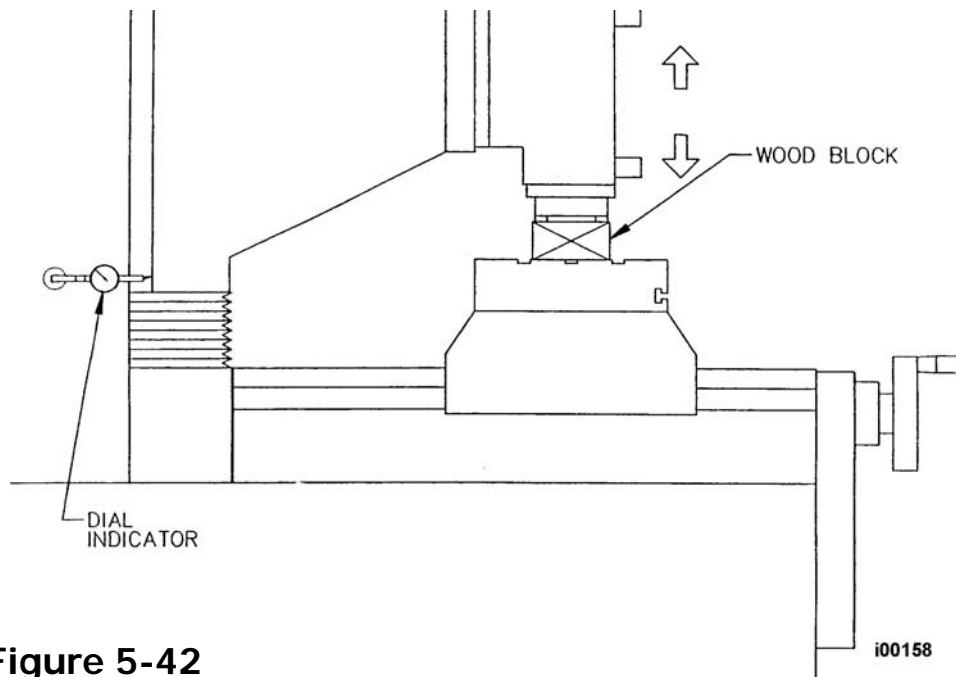


Figure 5-42
Ram Back Gib

6. Extend the quill until it touches the wood block. Using the quill handle, push the spindle nose against the wood block and note the amount of movement on the dial indicator. Adjust the left side gib until the registered movement is .001-.0015.

To adjust the gib for excessive clearance: Loosen the gib lock screw on the bottom of the ram. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the top of the ram. Tighten the gib lock screw on the bottom of the ram to lock the gib in place, and recheck. Repeat as necessary.

To adjust the gib for too small of a clearance: Loosen the gib lock screw on the top of the ram. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the bottom of the ram. Tighten the gib lock screw on the bottom of the ram. Tighten the gib lock screw on the top of the ram to lock the gib in place, and recheck. Repeat as necessary.

7. Run Service Code 12 to set the feed forward constant.
8. Repeat the procedure for the back gib on the right side of the machine.

5.2.1.5 Ram Side Gib Adjustment - Z Axis – TRM, DPM, DPM5, Sport B3, Sport B5, DPMS3, & DPMS5

1. Clean all chips, dirt and excess oil from the column ways.
2. Attach a .0001 dial indicator with a magnetic base towards the rear of the table on the right side of the ram. Place the indicator stylus on the ram in line and below the lower mounting bolt for the coolant hose connector block. (See Figure 5-43).

3. Lock and unlock the lower ram side gib lock and note the amount of movement on the dial indicator. Adjust the ram side gib until the registered movement is .0005- .0010.

To adjust the gib for excessive clearance: Loosen the gib lock screw on the bottom of the ram. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the top of the ram. Tighten the gib lock screw on the bottom of the ram to lock the gib in place, and recheck. Repeat as necessary.

To adjust the gib for too small of a clearance: Loosen the gib lock screw on the top of the ram. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the bottom of the ram. Tighten the gib lock screw on the top of the ram to lock the gib in place, and recheck. Repeat as necessary.

4. Run Service Code 12 to set the feed forward constant.
5. Reattach the upper and lower way cover to the ram.

CAUTION!

Be careful not to over tighten the ram gibs. Over tightening may lead to faulting and repeatability problems. Double-check the gib adjustment by checking the torque on the Z-axis. Use an in-lb torque wrench on top of the ball screw and typical readings should be from 12 to 17 in-lbs and consistent across the Z travel.

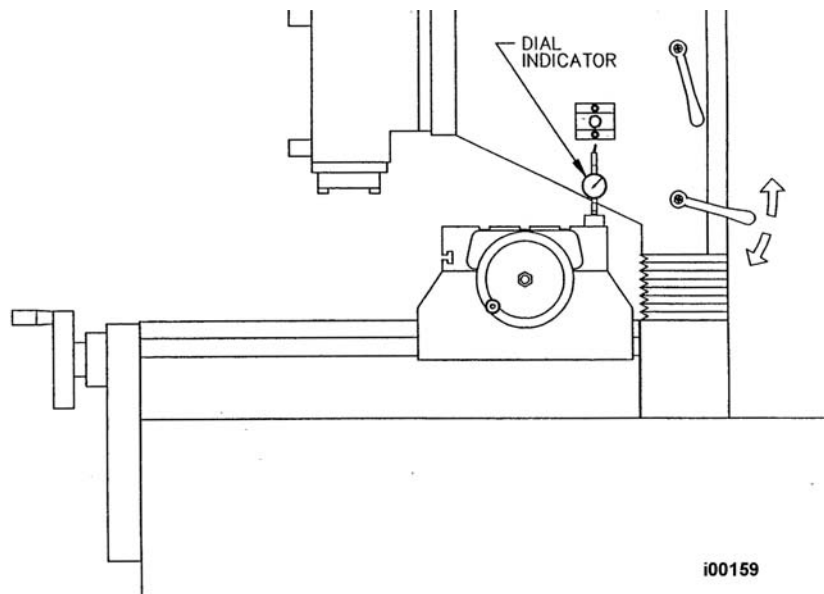


Figure 5-43 Ram Side Gib Adjustment

**5.2.2 Calibration & Backlash Constants -
Sport B3, Sport B5, DPMS3, DPMS5, & DPME2**

Calibration and backlash constants were set as part of the installation and set-up of your system. They should be re-set when indicated in the Troubleshooting section or after the replacement of the Computer module, or any parts of the drive train.

5.2.2.1 X, Y, Z (Ram) and Quill Calibration – DPMS3, DPMS5, & DPME2

Calibration is used to teach the machine a known distance. We typically calibrate our machines over a 150 mm distance. There is no limit to how far you can calibrate the machine. Refer to Figure 5-44.

1. If you have installed TRAK Sensors, move each axis through its travel 4-6 times in order to allow the gage wheel to establish its track.
2. Set-up a gauge block or standard and indicate it parallel to the axis you are calibrating.

Note: Put the display in Inch or mm to match your gage block. Recommended gage blocks are:

- X and Y -- 150mm or 6"
 - Z -- 75 mm or 3"
3. Set a 0.0001" indicator in the spindle and move it up to one side of the gage block or standard.
 4. Go to setup mode, go to section "B" and press CODE 123.
 5. Select the axis you want to calibrate X, Y or Z. For the quill press the F1 key labeled QUILL.
 6. Follow the instructions on the screen to complete calibration.

5.2.2.2 Z Ram Ball Screw Calibration – DPM only

Whenever the Z Ram ball screw or system TRAK A.G.E. computer module is replaced, the Z Ram motion must be recalibrated.

1. Create a set up similar to that shown in Figure 5-44, except orient the gage block and reference to measure vertical ram motion.
2. Lock the quill.
3. Press MODE, SET-UP, SERV CODES, 124, INC SET.
4. Follow the instructions on the screen.
5. If the difference between the measured length and standard length is more than 0.75 percent (no ballscrew has this much error), check your standard and repeat the procedure.

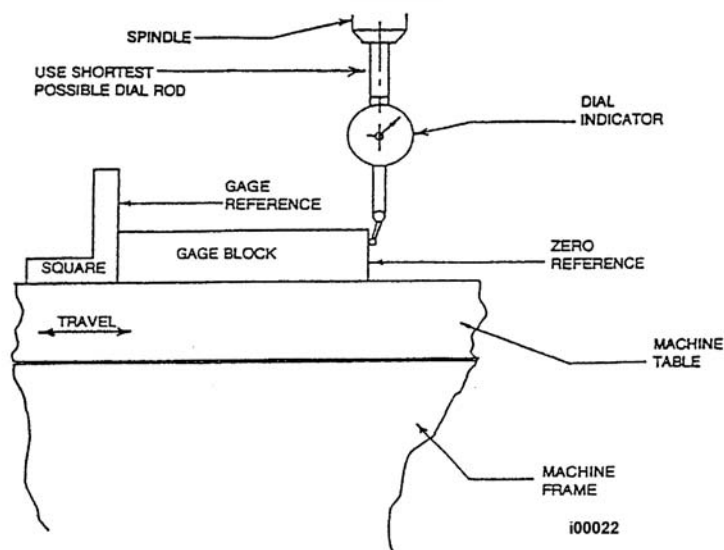


Figure 5-44 Calibration Set-Up

5.2.2.3 Backlash Compensation –MX2, MX3, AGE2, AGE3, Optional for M3, SM3

Code 11: Set X or Y backlash constant

Note: this procedure is on systems with dual feedback only.

Go to setup mode, SERV codes, and enter CODE 11. Refer to service codes in Section 4.11 for further explanation.

Code 127: Set X or Y Backlash Constant

Note: this procedure is only for systems without single feedback M/SM, EDGE.

Every mechanical system has at least a little backlash or lost motion. It is produced by the small amount of play between the gibs and ways, and mostly by the accumulative bending or elasticity of all the parts of the drive train under load. The backlash constant is factory set, but may need to be adjusted periodically.

1. Set a .0001-inch dial indicator in the spindle, and touch off on a block or the vise along the direction (X, Y or Z) you wish to check, or set the backlash constant.
2. Turn on the ProtoTRAK and at the Main Menu, follow the procedure below precisely:

Conversation Says	You Do
a. ---	a. Press MODE
b. Select Mode	b. Press SET UP
c. Select	c. Press SERV CODES
d. Select	d. Press "B"
e. Select Code 127	e. Press X or Y or Z
f. Backlash Value = _ _ _ _	f. What is shown is the current value. Follow the instruction on the screen and press the appropriate soft keys. Wait a few seconds between each INCR VALUE or DECR VALUE press.
g. The following is an example of what you might see when running this code.	For example, if the up and down "Oscillation Value" shown in the conversation line is .00278 inch, and the dial indicator is moving back and forth .0012, the true backlash value is .00278 - .0012 = .00158 inch. Input this by pressing MODE, SET UP, SERV CODE, 128, SET and then .00158, SET, RETURN.

- The X backlash identified and stored in Step 2 should be less than 0.003" on a new machine. If it is appreciably larger, inspect the drive train for loose bolts, brackets, bearings, etc.

The backlash can also be found manually with a 0.0001" indicator with the following method.

- Load the indicator to zero from one direction and zero out the DRO.
- Move the indicator to 0.002" and then back to zero. Do not over shoot 0, otherwise start over.
- Whatever number appears on the screen is the backlash value.
- Enter this value into service code 128.
- After entering this number redo the process. The DRO and indicator should now both read 0.

CODE 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters. This code is only used on machines with motor encoders only.

5.2.3 Head Rotation and Tramming

The TRAK Bed Mills head is free to rotate up to 90 degrees to the right or left.

5.2.3.1 To Rotate the Head:

- Loosen the four locknuts.
- Rotate the head with the adjusting worm shaft.

Note: Make sure to support head when exceeding 45° angle.

3. Tighten the locknuts. Snug each locknut, then lightly tighten each locknut, then fully tighten each locknut in a crisscross pattern.
4. Use the method shown in Figure 5-45 and a parallel bar to square the head to the table.

5.2.3.2 Tramming the Head

The purpose of tramming the head is make sure the head is perpendicular to the top of the table from both side to side and back to front.

Side to side tolerance – 0.001"

Side-to-Side Alignment

1. Make sure the machine is level.
2. Make sure the table has been clean and the Z gibs are adjusted properly. Mount a dial indicator in a tool holder and mount in the quill.
3. Adjust the Y-axis so that the spindle is in the center of the table.
4. Adjust the Z ram so that the dial indicator will reach the table.
5. Move the dial indicator to 6 o'clock position and adjust the face so the needle is zero.
6. Do a series of sweeps from 3 o'clock to 9 o'clock and check for the repeatability of the setup. The head should be trammed with an 0.001"
7. If the head is out of tram from side to side, loosen the 4 head bolts and rotate the head with the worm shaft.
8. Once the head has been trammed tighten the 4 heads bolts. Be careful not to move the head while tightening. Tighten the bolts in a criss-cross pattern.

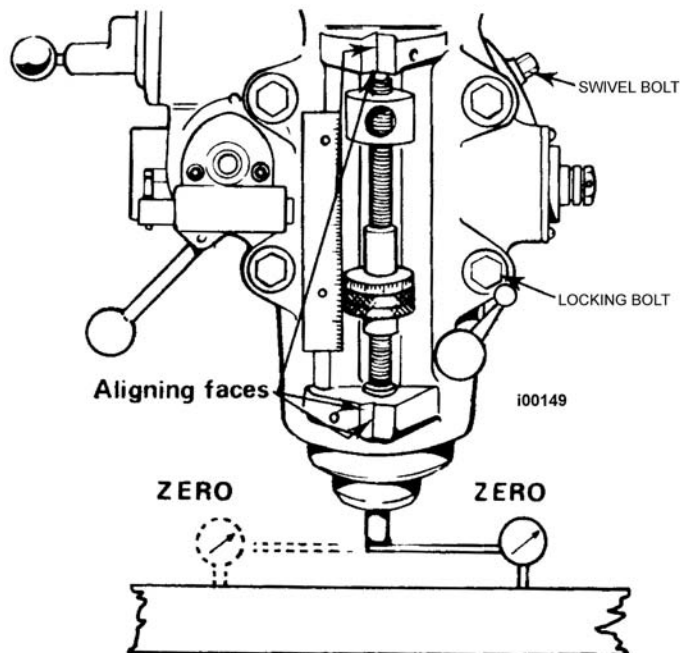


Figure 5-45
Tramming of Head

Back to Front Adjustment

Note: The head of the bed mill machine is adjusted at the factory. This procedure should only be needed for a head replacement.

Using the dial indicator, sweep the table from 6 o'clock to 12 o'clock. The head should be trammed within 0.0000 to 0.0005" from front to back. (Note: the head must droop down rather than up because tool pressure will take care of the extra 0.0005".)

Note: Minor adjustments can be made with the back ram gibs. Tightening the gibs will tend to tilt the head up from the table. Loosening the gibs tends to allow the head to droop down toward the table. Over tightening or loosening can lead to other problems with the machine. Typical adjustments with the gibs is 0.0005" or less.

5.2.4 Limit Switch Option – DPMS3, DPMS5, & DPME2

5.2.4.1 X-Axis Limit Switch-Stop Installation and Adjustment

The limit switch-stops for the X-axis are mounted to the front side of the table. The limit switch-stop consists of a square bracket, which is fastened to the T-slot on the front side of the table. Each limit switch-stop must be set to a specific distance from the end of the table in order to maximize travel and simultaneously prevent serious damage to the machine in the event of a crash. All limit switches are set at the factory for maximum travel.

Procedure for Setting X Limit Switch

1. Loosen the X-axis square bracket on each side of the table.
2. Slide each X-axis square bracket within the T-slot to the end of the table.
3. Slowly move the table to one side by hand until the end of the travel is reached.
4. In DRO mode set X = 0 ABS.

CAUTION!

The limit switch must be triggered a minimum of 1/2" before the machine reaches its travel limits in both directions. This allows sufficient room for the servomotors to stop when the limit switch is hit at 150 ipm.

5. Using the DRO display, back the table off 1/2".
6. Lock the limit switch bracket in place.
7. Jog the table at 150ipm to each side and verify that the limit switch is working properly. Also, make sure that the table does not exceed its travel and crash.

5.2.4.2 Y & Z-Axis Limit Switch-Stops

The limit switch-stops for the Y-axis are mounted on the side of the bed. The limit switch is triggered by hitting the cam stop on the saddle. The cam is placed to ensure maximum travel.

The limit switch-stops for the Z-axis are mounted on the side of the column. The limit switch is triggered by hitting the trip lever. After contact is made with the limit switch,

lift the trip lever and jog the head up or down to move the machine away from the limit. The trip levers are placed to ensure maximum travel.

5.2.5 Accuracy and Repeatability Measurements

Positional accuracy and repeatability programs are included in the program list of the control. Use these programs to check positional accuracy, uni-directional repeatability, and bi-directional repeatability. These programs are used to check each machine during the assembly process and can be utilized for checking the machine in the field when necessary.

1. Set-up a gage block or standard and indicate it parallel to the axis you are checking. Recommended gage blocks are 150 mm or 6.0 inches for X and Y, 75 mm or 3.0 inches for Z.
2. Set a 0.0001" indicator on the spindle and move it up to one side of the gage block or standard. If using a 150 mm standard position the flats toward the motor side of the table for the X-axis, position the flats toward the Z column for the Y-axis
3. Select the axis you want to check by selecting the appropriate program file as stated in the above paragraph.
4. When running the program, rotate the standard out-of-the-way of the oncoming indicator. The program will allow sufficient time to turn the standard for a clear path after which time it can be turned again for another reading.

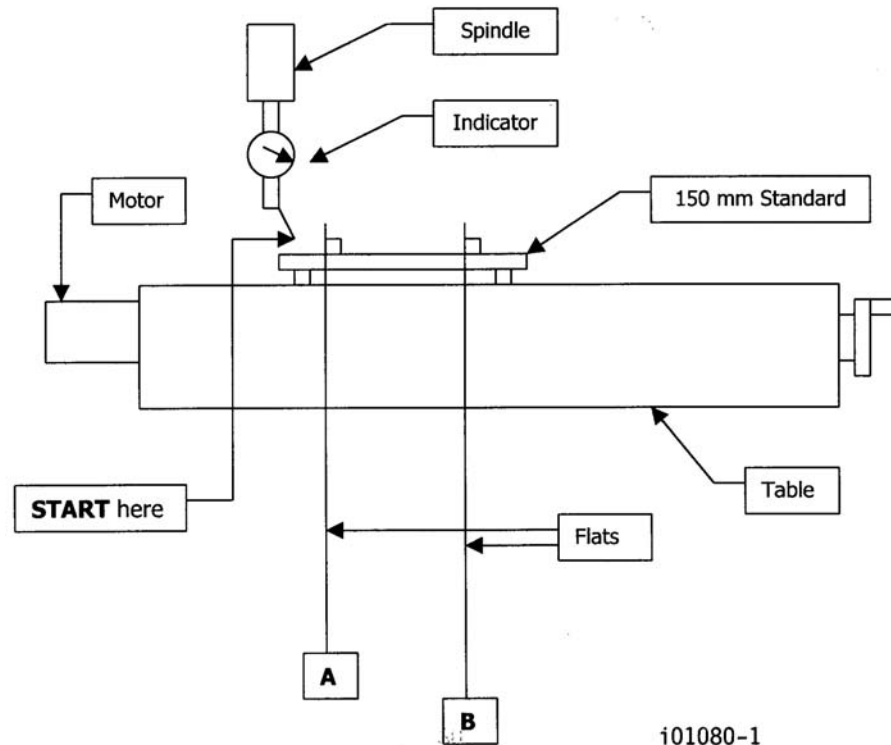


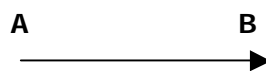
FIGURE 5-46
Typical set-up for an X-axis accuracy/repeatability check

5.2.5.1 The Program for the X-axis Will Run as Follows:

Movement from START to point A (about 2.0" of travel)

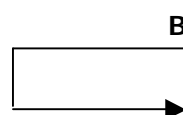
From the **START** position, manually advance the table to position A. Then zero out the indicator and the DRO at point A. Set the Z-retract position. (To set Z-retract, first set the DRO at the desired value [X,Y,Z=0]; then press **JOG** and move Z to +2.0 inches. Then press **MODE**, press **RUN**, press **SET Z RETRACT** then press **INC/ABS SET**.) Turn the flat (position A) out of the way so the indicator will not crash into it. Run the program. After the indicator starts to move away from position A, turn the flat back into place so the indicator will read position B. After reading position B it will backup about 4 inches and return to read position B again. Turn the flats out of the way again to allow the indicator to move beyond position B about 3 inches at which time it will return to position B. Return the flats to the readable position again to read the position at B.

Movement 1



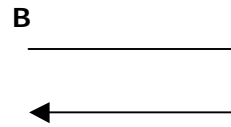
Pause. Record indicator reading. Press "Go".

Movement 2



Pause. Record indicator reading. Turn flat away from the path of indicator travel. Press "Go".

Movement 3



Pause. Turn flat so position B is readable again. Record indicator reading. End program.

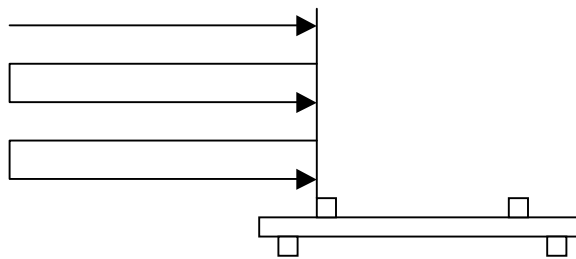
Movement 1 **Positional Accuracy** -- Checks the calibration of the machine. Typical values for a new machine are 0.0005" or less.

Movement 2 **Uni-directional Repeatability** -- Measures how well the machine comes back to a point from one direction. Typical values for a new machine are 0.0005" or less.

Movement 3 **Bi-directional Repeatability** -- Measures how well the machine comes back to a point from both directions. This value when measured is the difference between the uni-directional value and the value from the other direction. Typical values for a new machine are 0.0005" or less.

Example -- If the uni-directional value was -0.0002" and the value from the other direction is +0.0002", the bi-directional repeatability value is 0.0004".

Other considerations for accuracy or repeatability are: (1) Is it constant? (2) Is it random? (3) Is it changing at a particular rate. This leads to the possibility of running the program several times or manually running a repeatability test. For example: Set the indicator on the flat of position A. Zero the indicator and the DRO. Move away from the flat about 4 inches then return to read the flat and record the result. Do this approximately 6 times for positional accuracy/repeatability concerns. The following is an example for manually checking positional accuracy/repeatability.



i01080-3

5.2.5.2 *The Program for the Y-axis Will Run as Follows:*

The Y-axis program will function in relatively the same way as the X-axis program. Set-up is the same except that the Y direction it utilizes a different program file.

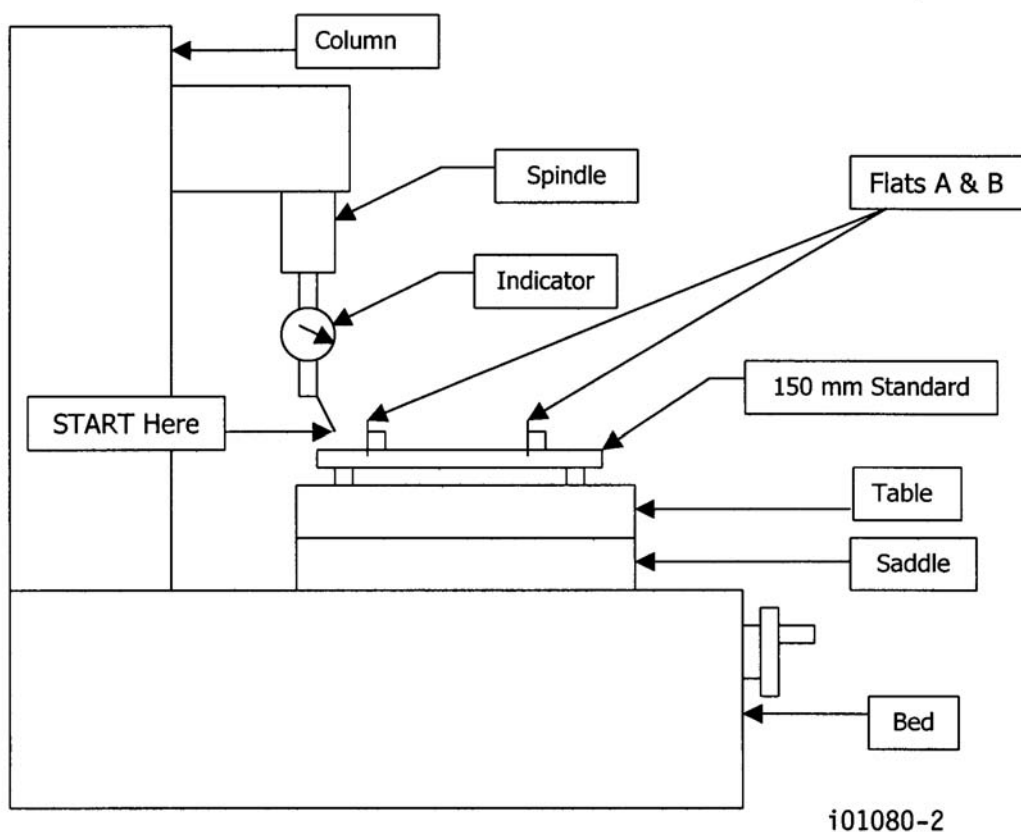


FIGURE 5-47
Typical set-up for a Y-axis accuracy/repeatability check

5.2.5.3 The Program for the Z-axis

1. Place a 75 mm gage block on the table. (One end of the 3.0-inch dimension in contact with the table and the other end touching off the indicator.) Set a 0.0001" indicator on the spindle and move it to read the top of the 77 mm gage block.
2. Set the indicator and the DRO X, Y & Z values to zero, and set Z-retract at this position also. Then press **MODE**, press **RUN**, press **SET Z RETRACT** then press **INC/ABS SET**.)
3. To run the program, press **MODE**, **RUN**, **START**, **GO**.
4. Press **GO** again and the Z-axis will move to -75 mm and stop. Record indicator reading. This is your positional accuracy value.
5. Press **GO**. Z moves up to zero then back down to -75 mm then stops. Record the change. This is the uni-directional repeatability value.
6. Press **GO**. Z will move to zero then stop. Move the 75 mm gage block back into position and note the indicator reading. This movement will yield the value for bi-directional repeatability. Record the reading. End.

7. Adjust backlash values as needed.

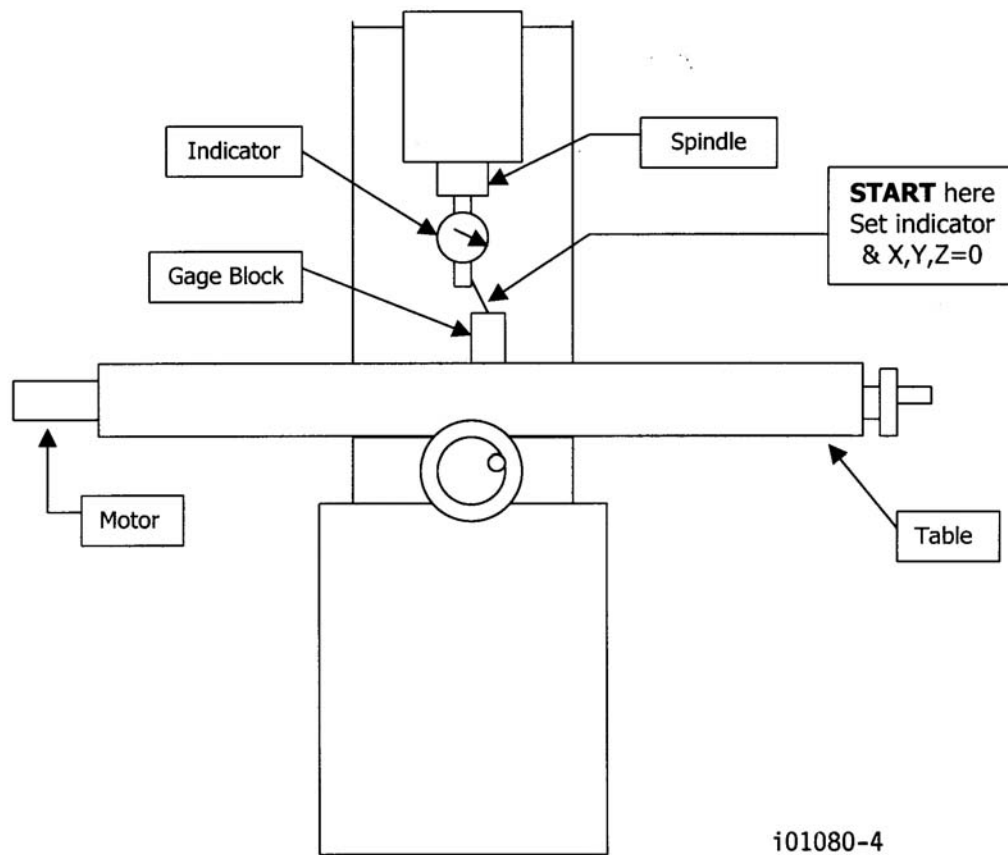
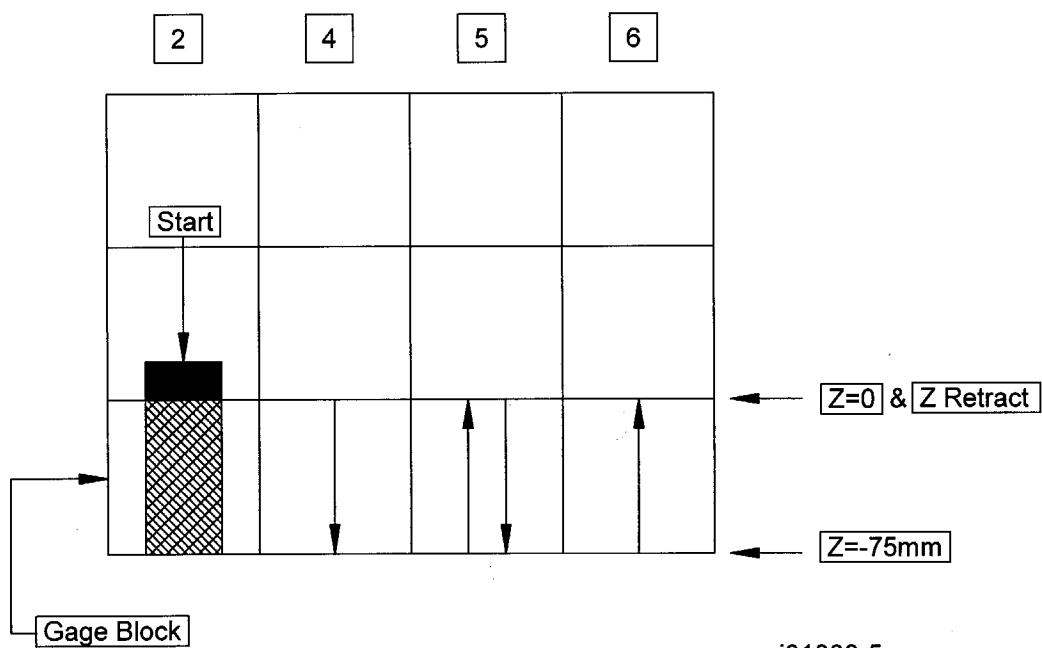


Figure 5-48
Typical set-up for a Z-axis accuracy/repeatability check

Program movement:



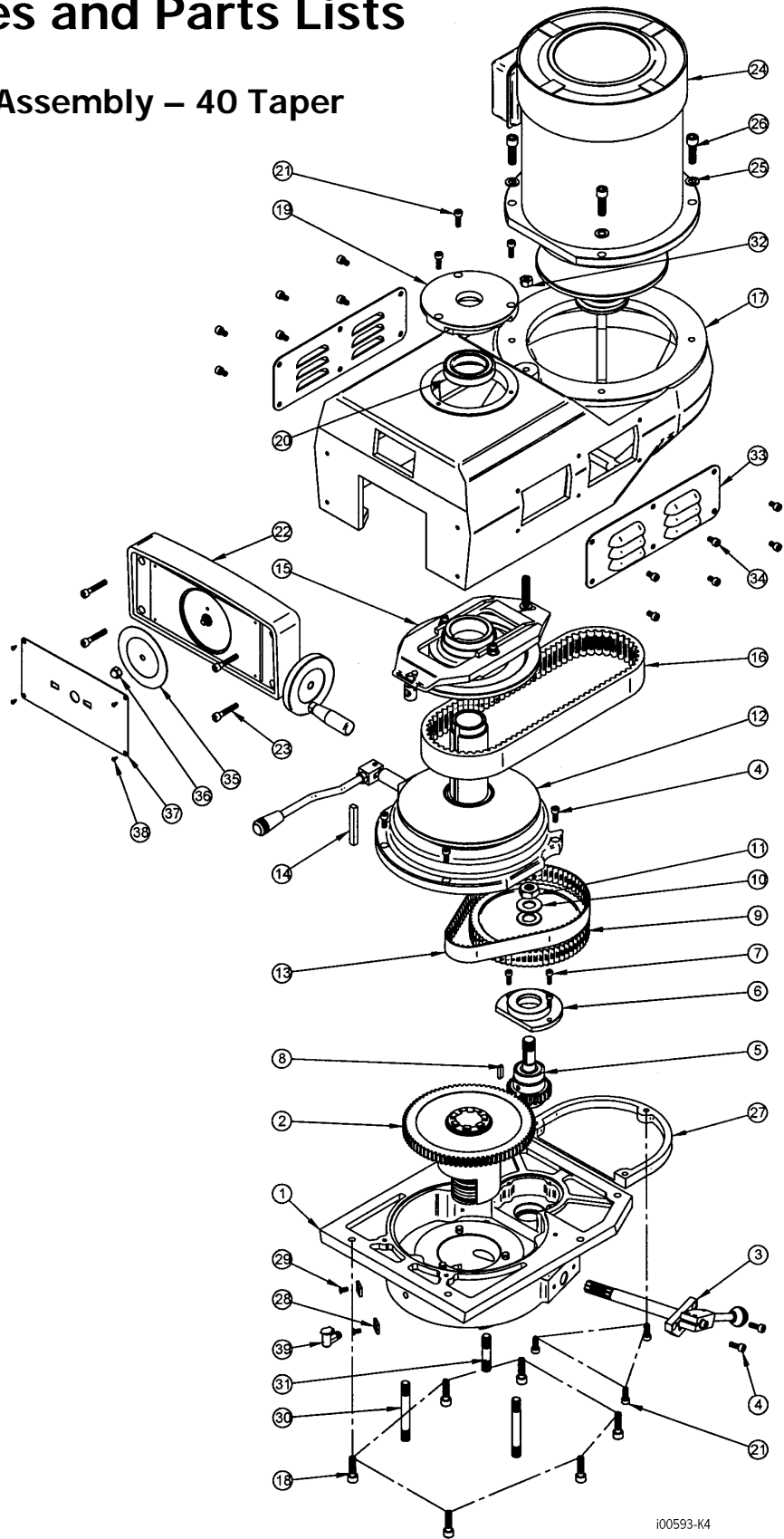
i01080-5

Figure 5-49
Program Movement

6.0 Figures and Parts Lists

Figure 100

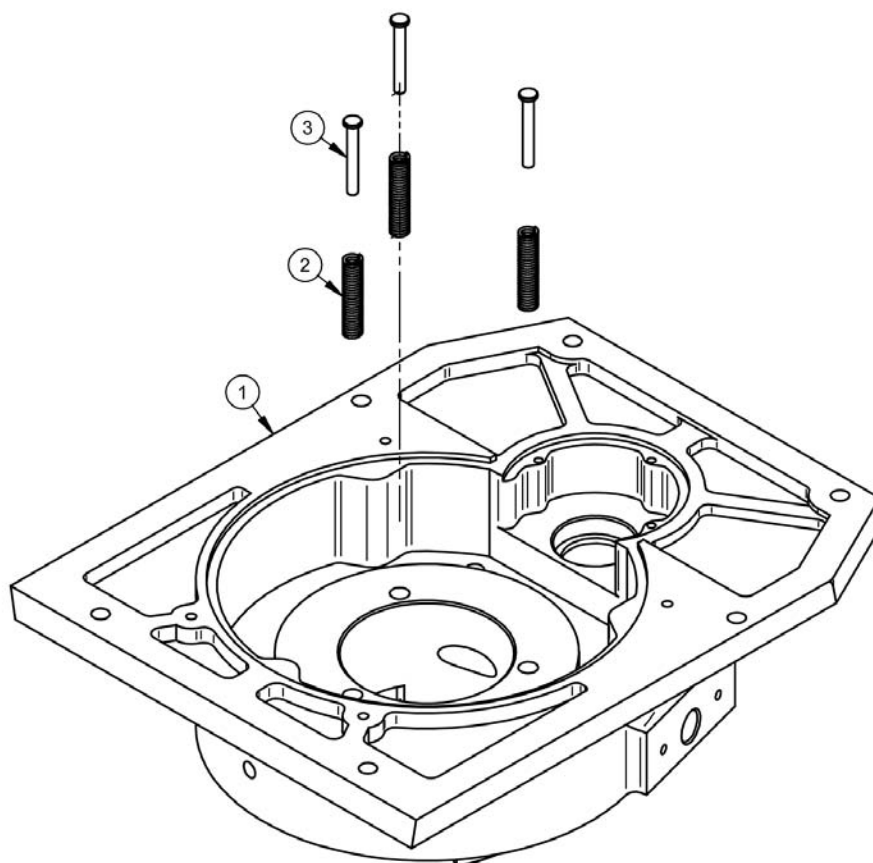
Top Housing Assembly – 40 Taper



Parts List - Top Housing Assembly – 24688-1

Item	P/N	DESCRIPTION	Qty
1	20697-1	GEAR HOUSING SUB-ASSY (4VK-A1)	1
2	20697-2	HI-LOW SHIFT CLUTCH SUB-ASSY (4VK-A2)	1
3	20697-3	HI-LOW SHIFT SUB-ASSY (4VK-A3)	1
4	FVS12	SOCKET CAP SCREW M6-P1.0x15L	2
5	20697-4	PULLY PINION SUB-ASSY (4VK-A4)	1
6	FVS64	BULL GEAR PINION BEARING CAP	1
7	FVS93	SCREW SOC HD M5-P0.8x15L	1
8	FVS117	KEY 5x520L	1
9	FVS62	TIMING BELT PULLEY	1
10	FVS126	WASHER Ø 5/8	1
11	FVS61	JAM NUT 5/8-11NC	1
12	20697-5	LOWER VARI-DISC DRIVE SUB-ASSY (4VK-A5)	1
13	FVS63	BELT 8YU-600L	1
14	FVS135	KEY 8x7x60L	1
15	20697-6	UPPER VARI-DISC DRIVE SUB-ASSY (4VK-A6) (Shown for reference only - See figure 106)	1
16	FVS4	BELT	1
17	FVS1	BELT HOUSING	1
18	FVS17	SOCKET CAP SCREW M6-P1.0x35L	1
19	FVS13	TOP BEARING CAP	1
20	FVS15	BALL BEARING (6909VV)	1
21	FVS129	SCREW- SOC HD CAP M6-P1.0x18L	1
22	20697-7	SPEED CHANGE HANDWHEEL SUB-ASSY (4VK-A7)	1
23	FVS10	SCREW- SOC HD CAP M8-P1.25x30L	1
24	20820-1	MOTOR ASSY-DPM5-5HP-WHITE (shown for reference only, not part of upper head housing assembly)	1
25	FVS130	WASHER- FLAT Ø 10.2	4
26	FVS111	SOC HD SCREW- 3/8-16NCx32L	4
27	FVS11	MOTOR PULLEY COVER	1
28	FVS104	COPPER CHIP(2REQ.)	2
29	FVS131	SCREW- FLAT HD PHILIP M5-P0.8x10L	1
30	FVS132	STUD Ø 7/16-92L	2
31	FVS133	STUD Ø 7/16-56L	1
32	FVS96	JAM NUT 3/8-16NC	1
33	FVS101	VENTILATOR (2REQ.)	2
34	FVS136	SCREW- SOC HD CAP M6-P1.0x10L	12
35	FVS16-1	VARI-SPEED DIAL	1
36	FVS95	HEX CAP NUT 5/16-18NC	1
37	FVS16-2	NAME PLATE	1
38	FVS19	DRIVE SCREW	1
39	OIL-1	FRU-K3-OIL CUP	1

i00593-K4

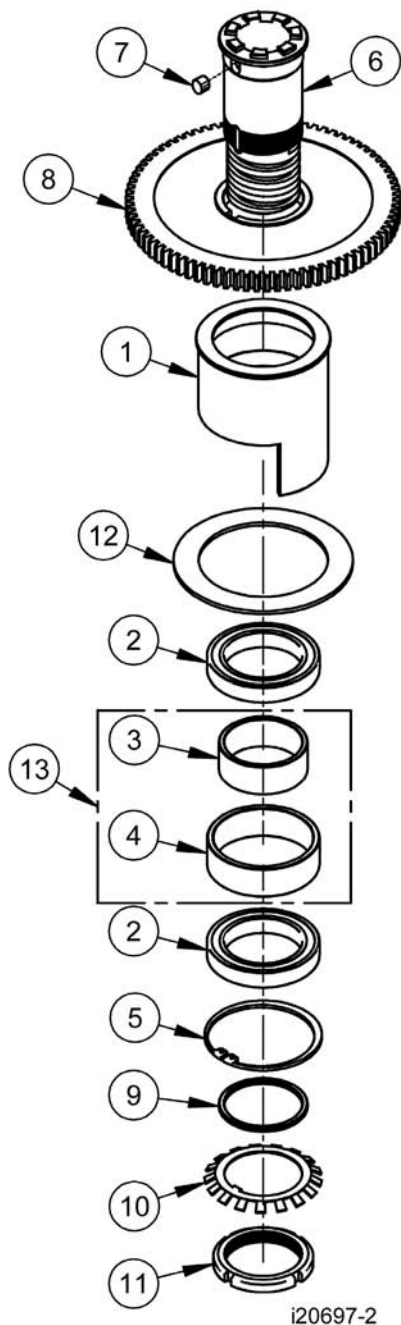


i20697-1

Figure 101
Gear Housing Sub-Assembly
P/N: 20697-1

Item	P/N	Description	Qty
1	FVS82	GEAR HOUSING	1
2	FV112	GUIDE SPRING	3
3	FV113	SPRING GUIDE PIN	3

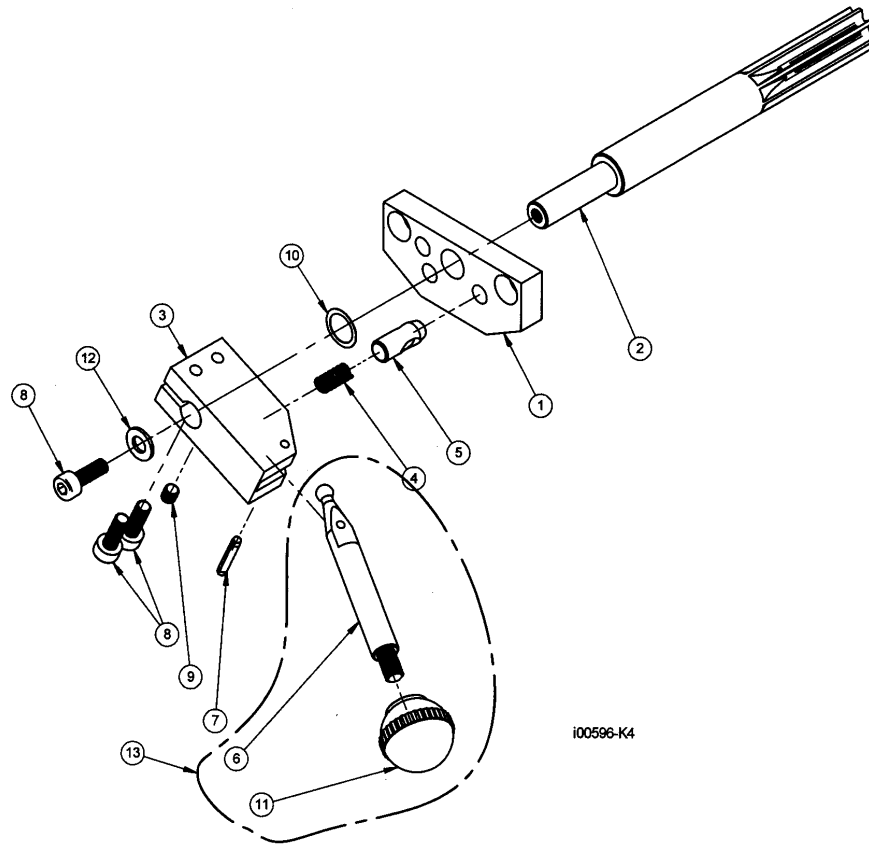
i00594-K4



Item	P/N	DESCRIPTION	Qty
1	FVS75	BEARING SLIDING HOUSING	1
2	23943	BEARING-DEEP GROVE U/SET (2)-6910ZZ	1 SET
3	FVS78	BEARING SPACER	1
4	FVS79	BEARING SPACER	1
5	FVS80	SNAP RING R-75	1
6	FVS73	SPLINED GEAR HUB	1
7	FVS72	KEY 8x7x10L	1
8	FVS74	SPINDLE BULL GEAR	1
9	FVS114	WASHER	1
10	FVS115	EXTERNAL TOOTH WASHER Ø 50	1
11	FVS81	LOCK WASHER Ø 50-18NC	1
12	FVS76	RING	1
13	20818	SPACER, BEARING	1

i20697-2

Figure 102
Hi-Low Slip Clutch
Sub-Assembly
P/N: 20697-2

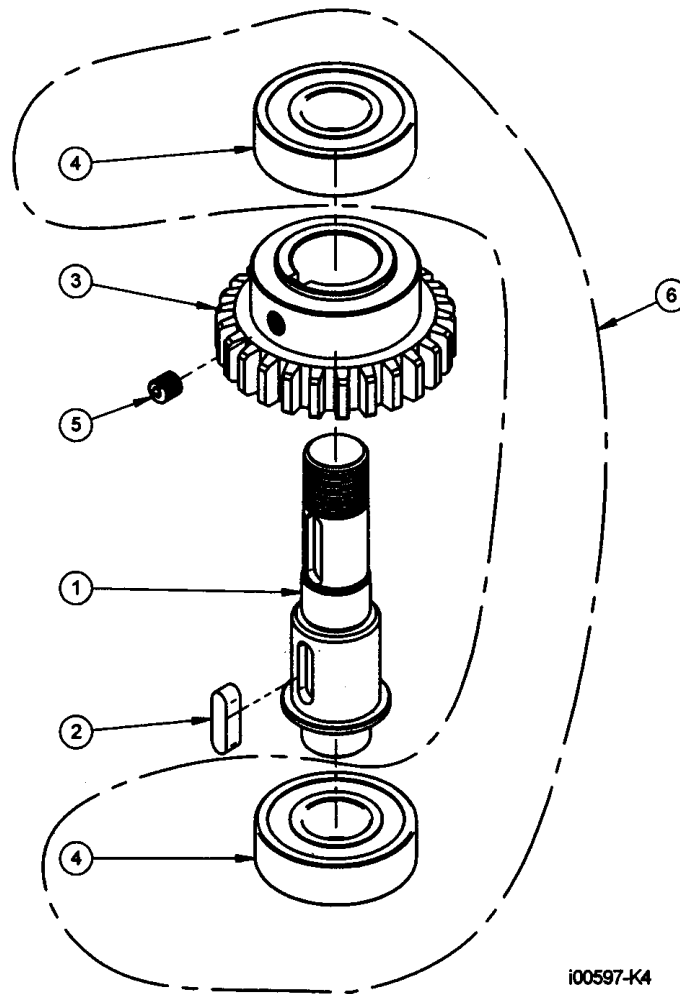


i00596-K4

Item	P/N	DESCRIPTION	Qty
1	FVS89	HI-LOW DETENT PLATE	1
2	FVS87	CLUTCH GEAR SHAFT	1
3	FVS92	HI-LOW PINION BLOCK	1
4	FVS91	SPRING	1
5	FVS90	HI-LOW DETENT PLUNGER	1
6	FVS94	HI-LOW SHAFT CRANK	1
7	FVS88	PIN Ø 319L	1
8	FVS93	SCREW SOC HD M5-P0.8x15L	3
9	FVS92-1	SET SCREW M5-P0.8x5L	1
10	FVS92-2	WASHER- FLAT Ø 11	1
11	FVS57	BAKELITE BALL HANDLE	1
12	FVS116	WASHER- FLAT Ø 6	1
13	24083	SHAFT HI/LOW SHAFT ASSY	1

i00596-K4

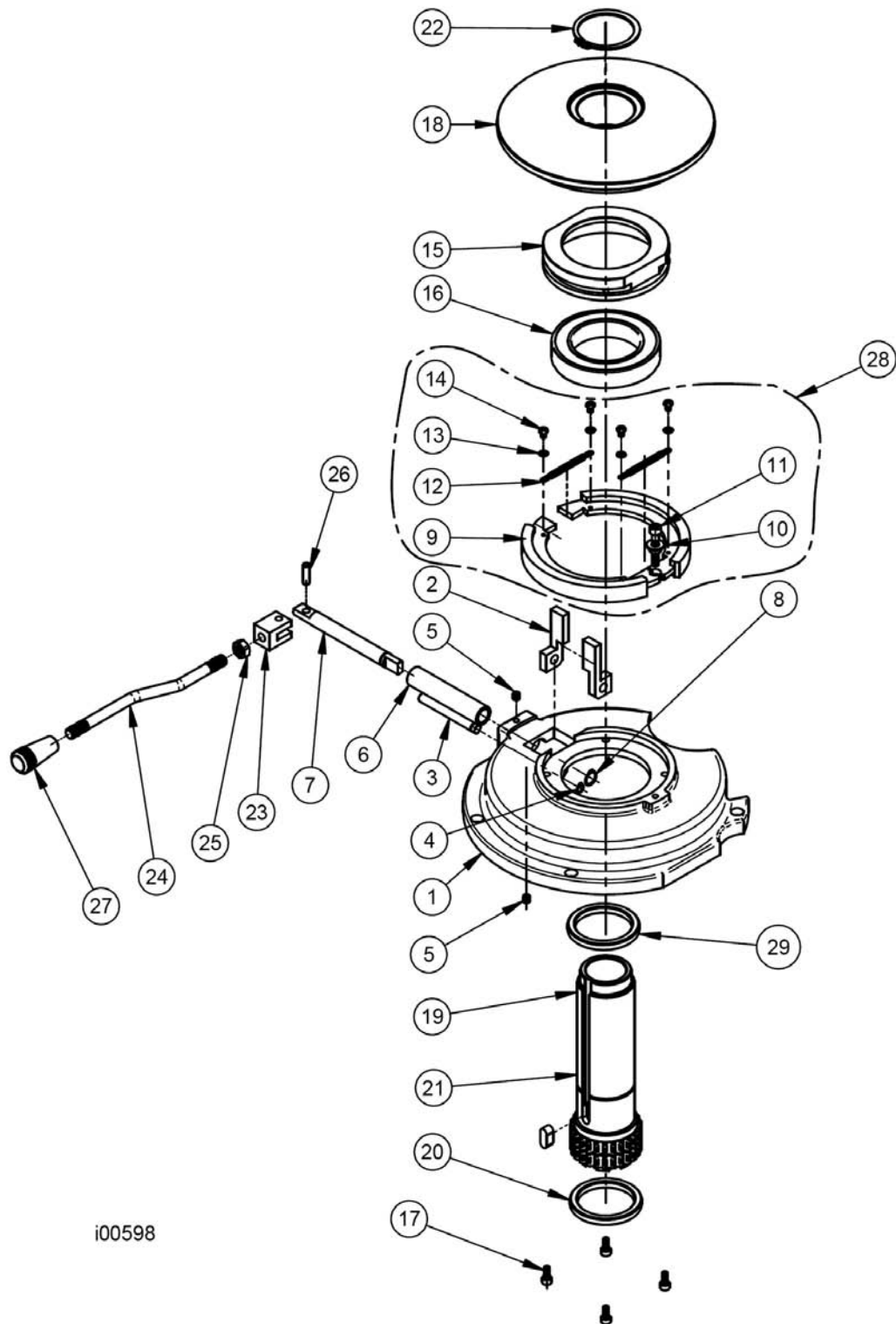
Figure 103
Hi-Low Shift Sub-Assembly
P/N: 20697-3



Item	P/N	DESCRIPTION	Qty
1	FVS67	BULL GEAR PINION COUNTER SHAFT	1
2	FVS69	KEY 5518L	1
3	FVS66	BULL GEAR PINION	1
4	AK118	BEARING-DEEP GROOVE-6203ZZ	2
5	FVS3	SOCKET SET SCREW M6-P1.0x6L	1
6	23954	BEARING-DEEP GROOVE-SET (2)-6203ZZ	1

i00597-K4

Figure 104
Pulley Pinion Sub-Assembly
P/N: 20697-4



i00598

Figure 105
Lower Vari-Disc Sub-Assembly
P/N: 20697-5 (assembly not available, order parts separately)

Parts List - Lower Vari-Disc Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FVS50	BELT HOUSING BASE	1
2	FVS59	BRAKE BLOCK	2
3	FVS58	TURNING BLOCK SHAFT	1
4	FVS103	RETAINING RING Ø 7	1
5	FVS51	SET SCREW M6-P1.06L	2
6	FVS53	BRAKE LOCK BUSHING	1
7	FVS52	BRAKE LOCK SHAFT	1
8	FSV119	RETAINING RING Ø 11	1
9	FVS47	BRAKE SHOE	2
10	FVS48	BRAKE SHOE PIVOT SLEEVE	1
11	FVS17	SOCKET CAP SCREW M6-P1.0x35L	1
12	FVS49	BRAKE SPRING	2
13	FVS122	WASHER Ø 6	4
14	FVS120	SCREW- PHILLIP PAN HD 3/16-24NC6L	4
15	FVS46	BRAKE BEARING CAP	1
16	AK048	BALL BEARING 6912ZZ	1
17	FVS14	SOCKET CAP SCREW M 5-PO.8x12L	4
18	FVS45	STATIONARY DRIVEN VARIDISC	1
19	FVS70	SPINDLE PULLEY ASSY	1
20	FVS100	SPINDLE PULLEY SPACER	1
21	FVS71	KEY 8x8x20L	1
22	FVS97	SNAP RING Ø 50	1
23	FVS52-1	BRAKE LOCK SHAFT SWIVEL	1
24	FVS56	BRAKE LOCK HANDLE	1
25	FVS54	HANDLE FIX BLOCK 3/8-16NC	1
26	FVS55	SPRING PIN Ø 6x20L	1
27	FVS57-1	BAKELITE BALL HANDLE 3/8-16NC	1
28	24055	BRAKE SHOE ASSY	1
29	FVS98	CLUTCH WASHER	1

i00598-K4

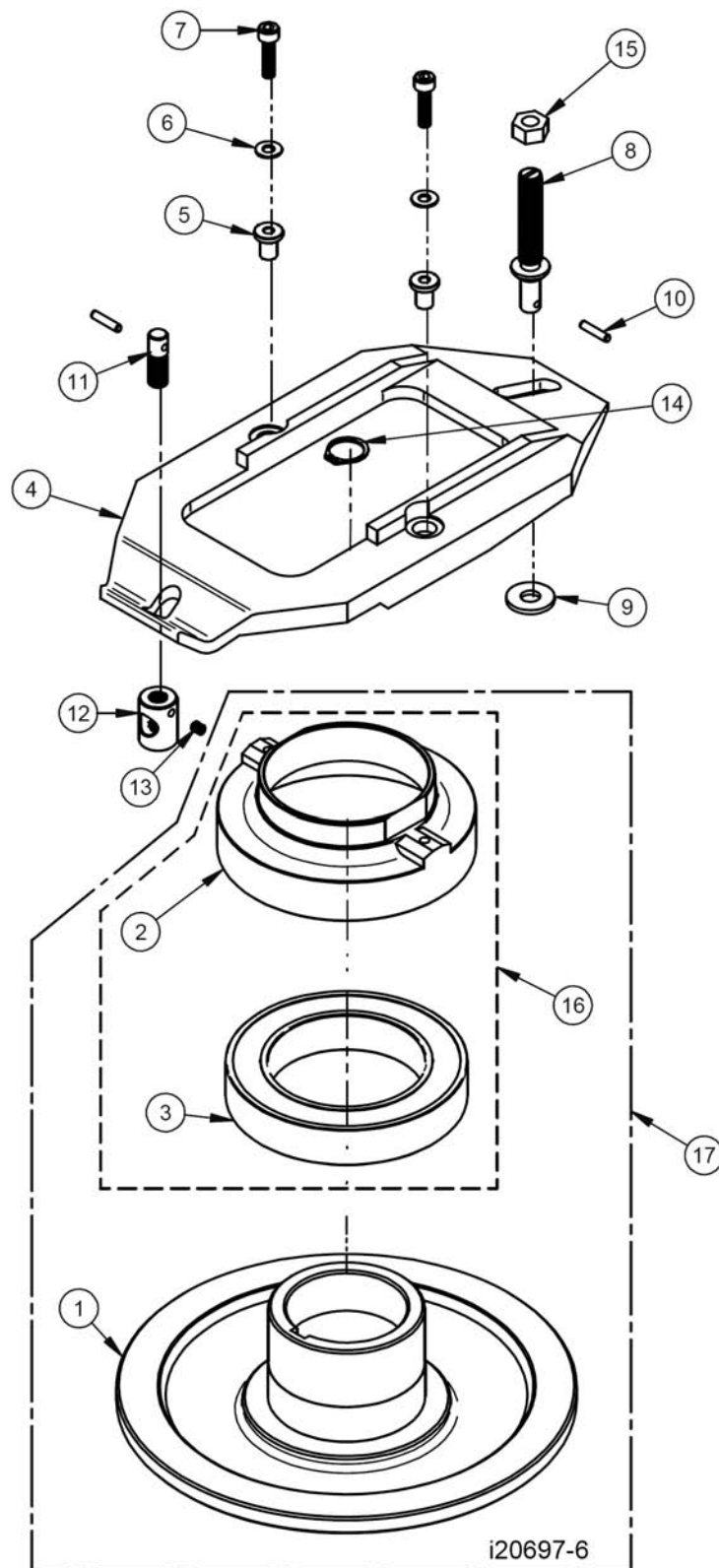
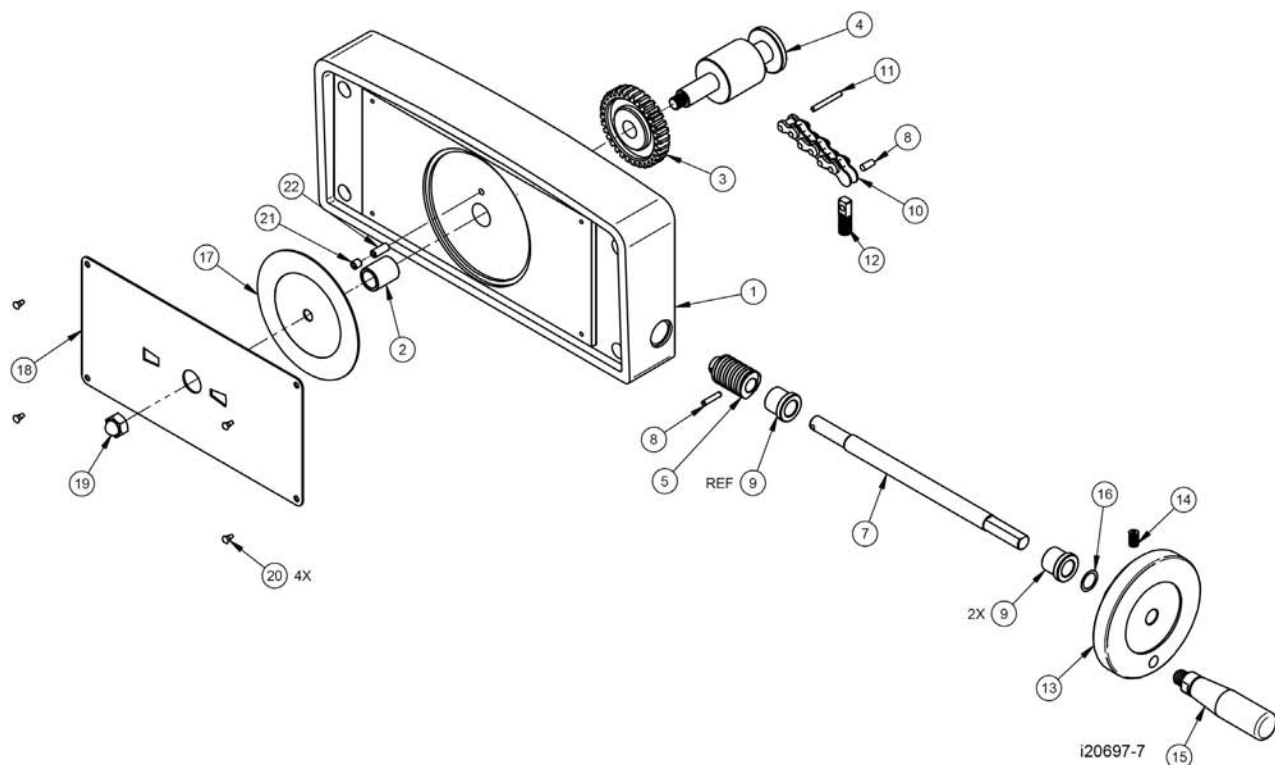


Figure 106
Upper Vari-Disc Sub-Assembly
P/N: 20697-6

Parts List - Upper Vari-Disc Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FVS44	ADJUSTABLE-DRIVEN VARIDISC	1
2	FVS42	SPINDLE PULLEY BEARING HOUSING	1
3	FVS43	BEARING-DEEP GROVE-6013ZZ	1
4	FVS36	SPEED CHANGE PLATE	1
5	FVS38	PIVOT SLEEVE Ø 5	2
6	FVS37	WASHER M5-P0.8x20L	2
7	FVS3123	SOCKET CAP SCREW	2
8	FVS39	SPEED CHANGE PLATE PIVOT STUD	1
9	FVS41	WASHER Ø 8.2	1
10	FVS40	ROLL PIN Ø3x15L	2
11	FVS35	CHAIN END STUD	1
12	FVS34	ADJUSTMENT NUT	1
13	FVS33	CHAIN FRONT SCREW M4-P0.7x5L	1
14	FVS97	SNAP RING Ø 50	1
15	FVS96	JAM NUT 3/8-16NC	1
16	24599	BEARING HOUSING ASSY-K4	1
17	24603	VARIDISC ASSY-ADJUSTABLE	1

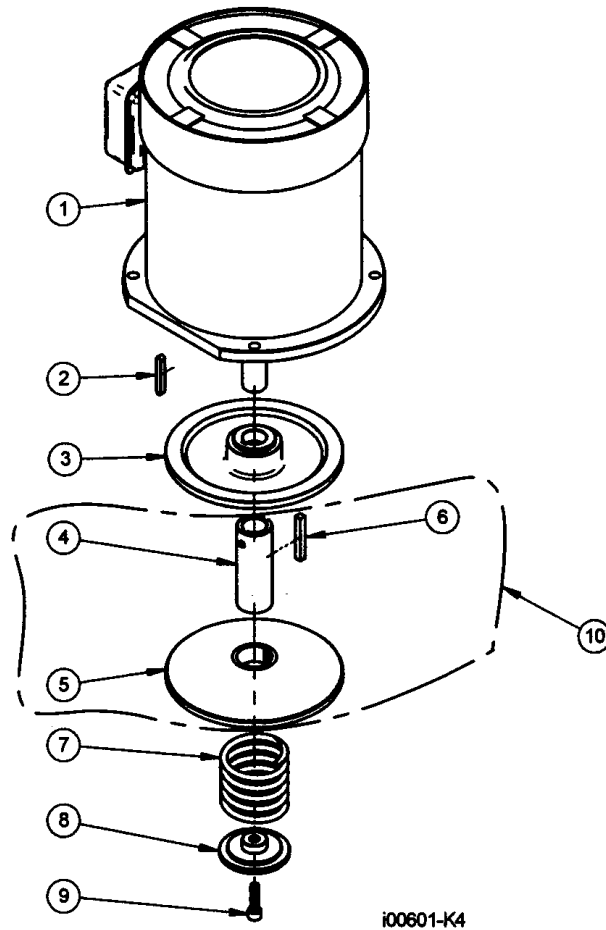
i20697-6



Item	P/N	Title	Qty
1	FVS16	SPEED CHANGE HOUSING	1
2	FVS20	BEARING SELF LUBRICATING	1
3	FVS22	SPEED CHANGER GEAR	1
4	FVS31	SPEED CHANGE CHAIN DRUM	1
5	FVS21	WORM	1
7	FVS25	SPEED CHANGE SHAFT	1
8	FVS40	ROLL PIN Ø3x15L	2
9	FVS24	COPPER BUSHING	2
10	FVS32	CHAIN #3109.525	1
11	FVS31-1	DOWEL PIN Ø3x25L	1
12	FVS30	SPEED CHANGE STUD	1
13	FVS27	SPEED CHANGE HANDWHEEL	1
14	FVS18	FULL DOG SOCKET SET SCREW M6-P1.0x10L	1
15	FVS28	HANDLE 3/8-16NC	1
16	VS24-1	WASHER-WAVE	1

i20697-7

Figure 107
Speed Change Handwheel Sub-Assembly,
P/N: 20697-7



Item	P/N	Title	Qty	Notes
1	FVS110	MOTOR 5 HP	1	only available as 20820-1
2	FVS3-1	KEY 6x6x45L	1	only available as 20820-1
3	FVS2	STATIONARY MOTOR VARIDISC	1	only available as 20820-1
4	FVS6	BUSHING	1	available as 24054 or 20820-1
5	FVS5	ADJUSTABLE MOTOR VARIDISC	1	available as 24054 or 20820-1
6	FVS6-1	KEY 7x7x50L	1	available as 24054 or 20820-1
7	FVS8	SPRING FOR VARIDISC MOTOR SHAFT	1	only available as 20820-1
8	FVS9	ADJUSTABLE VARIDISC SPRING COLLAR	1	only available as 20820-1
9	FVS10	SCREW- SOC HD CAP M8-P1.25x30L	1	only available as 20820-1
10	24054	VARIDISC ASSY	1	

i00601-K4

Figure 108
Spindle Motor Sub-Assembly
P/N: 20820-1

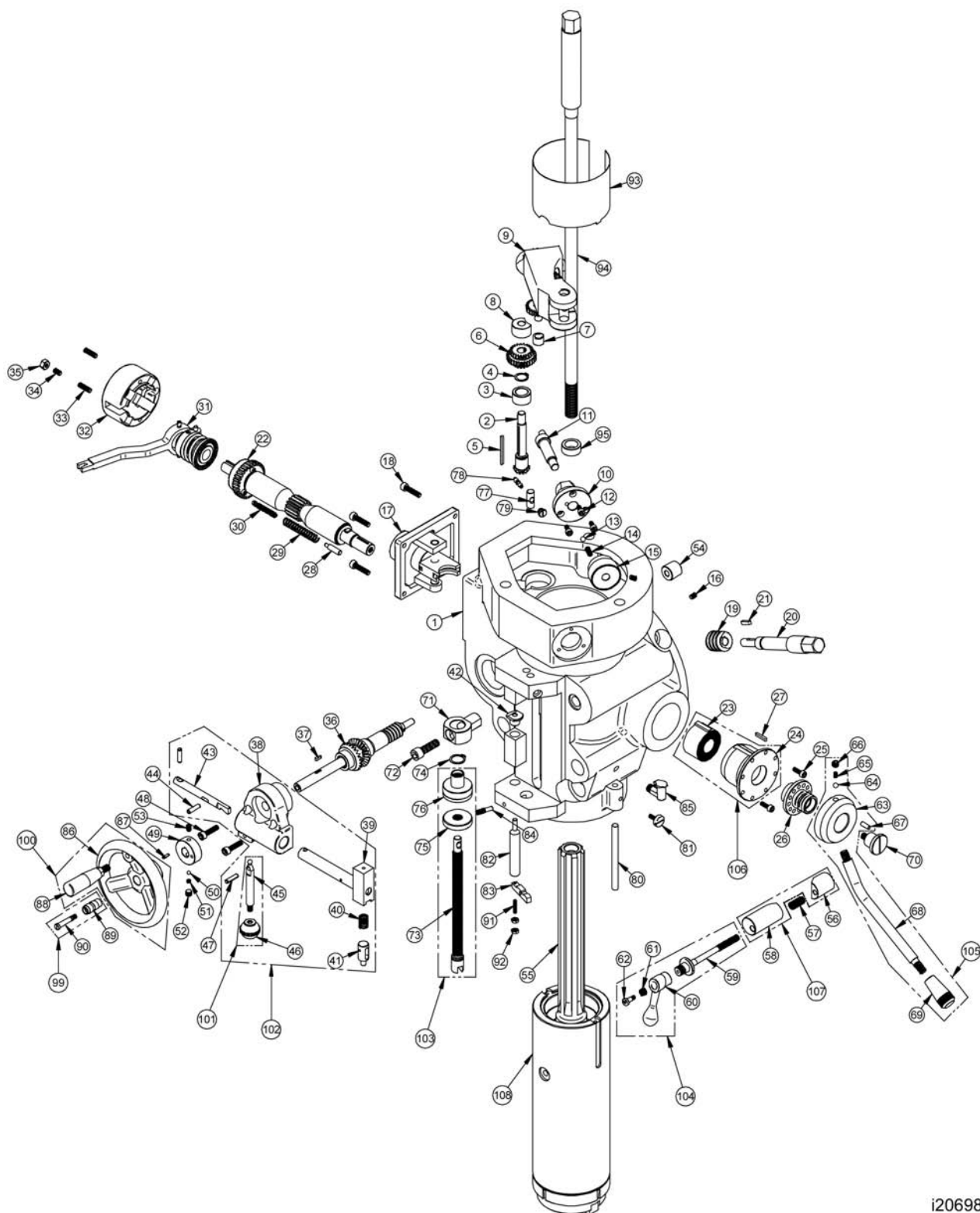


Figure 109
Bottom Housing Assembly

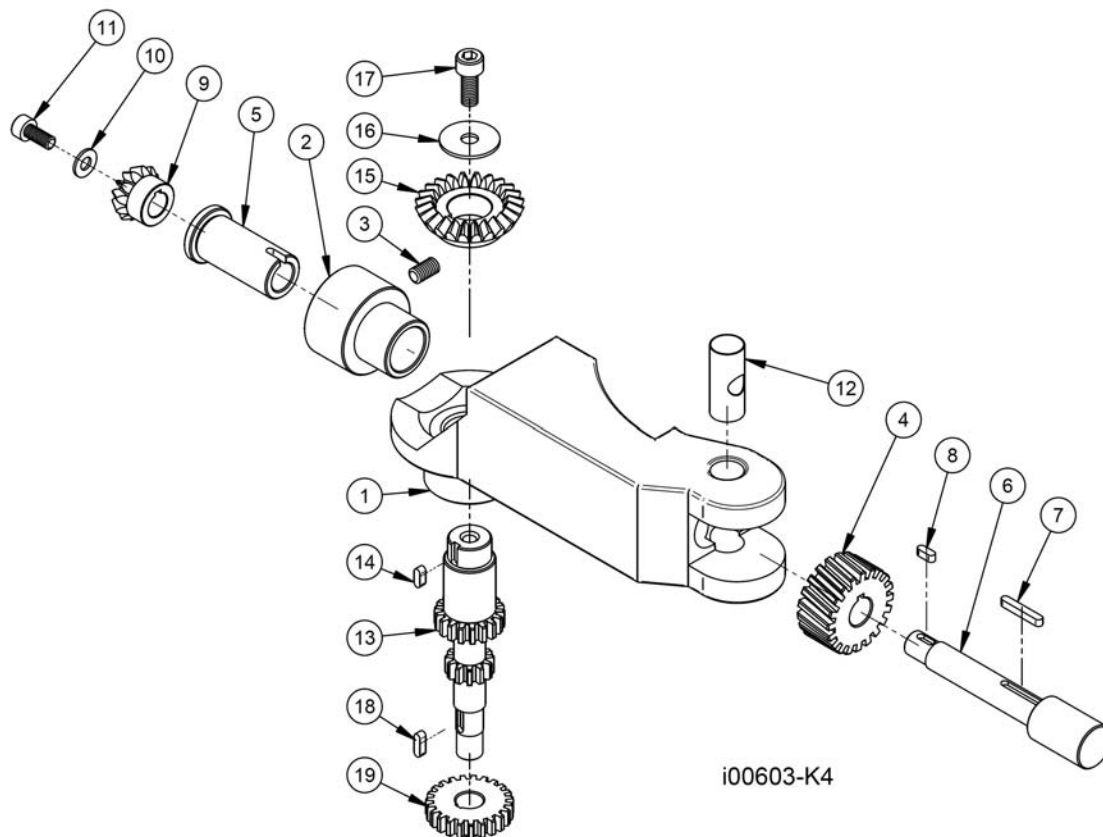
Parts List - Bottom Housing Assembly

Item	P/N	Title	Qty
1	FB192	QUILL HOUSING	1
2	FB31	CLUSTER GEAR SHAFT	1
3	FB33	BEVEL GEAR BEARING	1
4	FB94	SNAP RING 95 DOWEL PIN Ø 14	1
5	FB29	CLUSTER GEAR KEY 3x3x45L	1
6	FB28	CLUSTER GEARS ASSEMBLY	1
7	FB41	NEEDLE BEARING KO-BA66Z	1
8	FB27	CLUSTER GEAR SHAFT UPPER BEARING	1
9	20698-1	WORM GEAR CRADLE SUB-ASSY (4VK-H1)	1
10	FB19	SHIFT SLEEVE	1
11	FB18	WORM GEAR CRADLE THROW-OUT	1
12	FB20	CAP SCREW M5-P0.8x12L	1
13	FB24	STEEL BALL	1
14	FB25-A	SPRING	1
15	FB23	SHIFT CRANK	1
16	FB68	SET SCREW M6-P1.0x8L	1
17	20698-2	QUILL FEED SELECTOR SUB ASSY (4VK-H2)	1
18	FB67	CAP SCREW M6-P1.0x18L	4
19	FB186	WORM GEAR	1
20	FB189	ADJ WORM SHAFT	1
21	FB187	KEY 4x4x18L	1
22	20698-3	SUB-ASSY-QUILL PINION SHAFT-40 TAPER	1
23	FB178	CLOCK SPRING (CLOCK SPRING ASSY.)	1
24	FB177	SPRING COVER	1
26	FB176	PINION SHAFT HUB SLEEVE	1
27	FB171	KEY 3x3x20L	1
28	FB89	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1
29	FB88	COMPRESSION SPRING	1
30	FB88-1	INTERNAL COMPRESSION SPRING	1
31	20698-4	OVERLOAD CLUTCH TRIP SUB-ASSY (4VK-H4)	1
32	FB99	CLUTCH ARM COVER	1
33	FB73	CAP SCREW M5-P0.8x40L	2
35	FB101	CHEM BLACKED LOCKNUT M6-P1.0	1
36	20698-5	FEED REVERSE CLUTCH SUB-ASSY (4VK-H5)	1
37	FB109	KEY 3x3x20L	1
38	FB106	FEED TRIP BRACKET	0
39	FB118	CAM ROD SLEEVE ASSY.	1
40	FB120	COMPRESSION SPRING	1
41	FB121	TRIP PLUNGER	1
42	FB123	TRIP PLUNGER BUSHING	1
43	FB103	CAM ROD	1
44	FB117	ROLL PIN Ø 3x15L	1
45	FB104	TRIP HANDLE	1
46	FB105	BLACK PLASTIC BALL	1
47	FB119-1	ROLL PIN Ø 3x20L	1
48	FB107	CAP SCREW M6-P1.0x25L	2
49	FB113	HAND WHEEL CLUTCH	1

51	FB115	COMPRESSION SPRING	1
53	FB108	SET SCREW M6-P1.0x8L	1
54	FB42	BUSHING	1
55	20836-1	SPINDLE ASSY-40 TAPER	1
56	FB148	QUILL LOCK SLEEVE TAPPED	1
57	FB148-1A	COMPRESSION SPRING	1
58	FB153	QUILL LOCK SLEEVE	1
59	FB152	QUILL LOCK BOLT	1
60	FB149	LOCK HANDLE	1
61	FB149-1	CONICAL COMPRESSIONAL SPRING	1
62	FB149-2	SCREW- PHILLIP HD	1
63	FB175	RACK FEED HANDLE HUB	1
64	FB114	STEEL BALL	2
65	FB175-2A	COMPRESSION SPRING	1
66	FB116	HANDWHEEL CLUTCH SPRING SCREW M8-P1.25x6L	2
67	FB175-3	DOWEL PIN	1
68	FB190	PINION SHAFT HUB HANDLE	1
69	FB191	PLASTIC BALL HANDLES	1
70	FB169	SOC HEAD SCREW M5-P0.8x15L	4
71	FB163	QUILL STOP KNOB	1
72	FB200	SCREW- SOC HD 3/8-24NF x 1 1/4	1
73	FB164	QUILL STOP MICRO-SCREW	1
74	FB160	SNAP RING Ø16	1
75	FB161	QUILL MICRO-STOP NUT	1
76	FB162	MICROMETER NUT	1
77	FB184	FEED REVERSE TRIP PLUNGER	1
78	FB183	REVERSE TRIP BALL LEVER	1
79	FB185	REVERSE TRIP BALL LEVER SCREW	1
80	FB202	INDICATOR ROD	1
81	FB201	INDICATOR ROD SCREW	1
82	FB124	FEED TRIP PLUNGER	1
83	FB145	FEED TRIP LEVER	1
84	FB144	SOCKET SET SCREW	1
85	OIL-1	FRU-K3-OIL CUP	1
86	FB125	HANDWHEEL	1
87	FB125-1	HANDWHEEL SPRING PIN - Ø 3x3x10L	1
88	FB125-2	HANDWHEEL HANDLE	1
89	FB111	REVERSE KNOB	1
90	FB100	SOCKET SET SCREW M6-P1.0x20L	2
91	FB124-1	FEED TRIP PLUNGER SOC SET SCREW M4-P0.7x20L	1
92	FB124-2	FEED TRIP PLUNGER NUT M4-P0.7x20L	2
93	FB128	QUILL SKIRT	1
94	FVS109	DRAWBAR 5/8-11NC	1
95	FVS109-1	SPACER	1
96	25041	SCALE-HEAD ROTATION-NT40	1
97	25043	POINTER SCALE	1
98	25044	DRIVE SCREW-SCALE	4
99	20834	FEED REVERSE KNOB ASSY	1
100	20835	HANDWHEEL ASSY	1

101	24099	TRIP HANDLE ASS'Y (INCLUDES PLASTIC BALL)	1
102	20833	FRU-K4-FEED TRIP ASSY	1
103	20847	QUILL MICRO NUT & SCREW ASSY	1
104	20846	QUILL LOCK HANDLE ASSY	1
105	20850	FEED HANDLE ASSY	1
106	24095	CLOCK SPRING ASSEMBLY (SPRING & COVER)	1
107	20844	QUILL LOCK SLEVE ASSY	1
108	FB142	QUILL	1
109	A071	T BOLT ASSY (includes A070, A071, A069) (not shown on drawing)	4

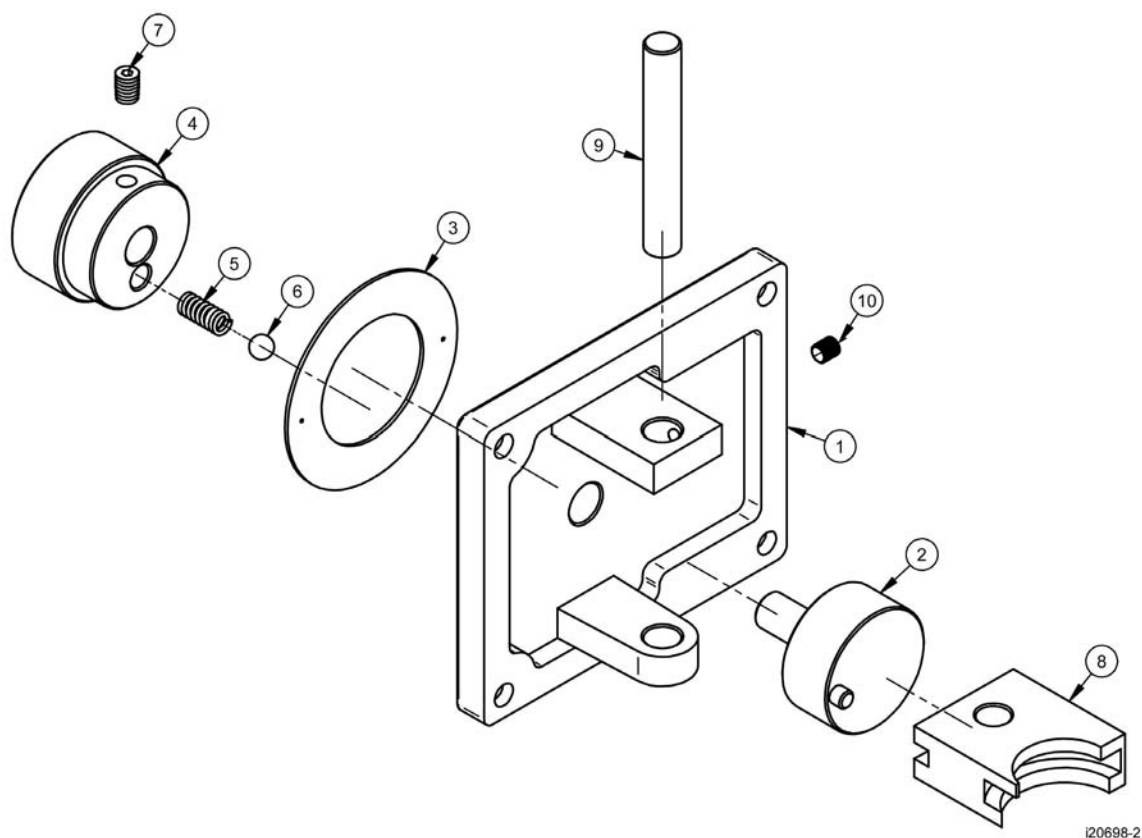
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Item	P/N	Title	Qty
1	FB17	WORM GEAR CRADLE	1
2	FB5	WORM CRADLE BUSHING	1
3	FB6	SETSCREW M6-PP1.0x10L	1
4	FB8	FEED DRIVEWORM GEAR	1
5	FB4	FEED WORM GEAR SHAFT SLEEVE	1
6	FB9	FEED DRIVE WORM GEAR SHAFT	1
7	FB11	KEY 3x3x20L	1
8	FB10	WORM SHAFT KEY 3x3x8L	1
9	FB3	FEED BEVEL PINION	1
10	FB2	BEVEL PINION WASHER Ø 5	1
11	FB1	SOC.HD.SCREW M5-P0.8x10L	1
12	FB16	FEED ENGAGE PIN	1
13	FB36	FEED DRIVING GEAR	1
14	FB36-1	KEY 3x3x8L	1
15	FB15	FEED REVERSE BEVEL GEAR	1
16	FB13	WASHER Ø 6 Ø 22	1
17	FB14	SOC HD SCREW M6-P1.0x15L	1
18	FB37	KEY 3x3x10L	1
19	FB40	FEED DRIVE GEAR	1

i00603-K4

Figure 110
Worm Gear Cradle Sub-Assembly
P/N: 20698-1

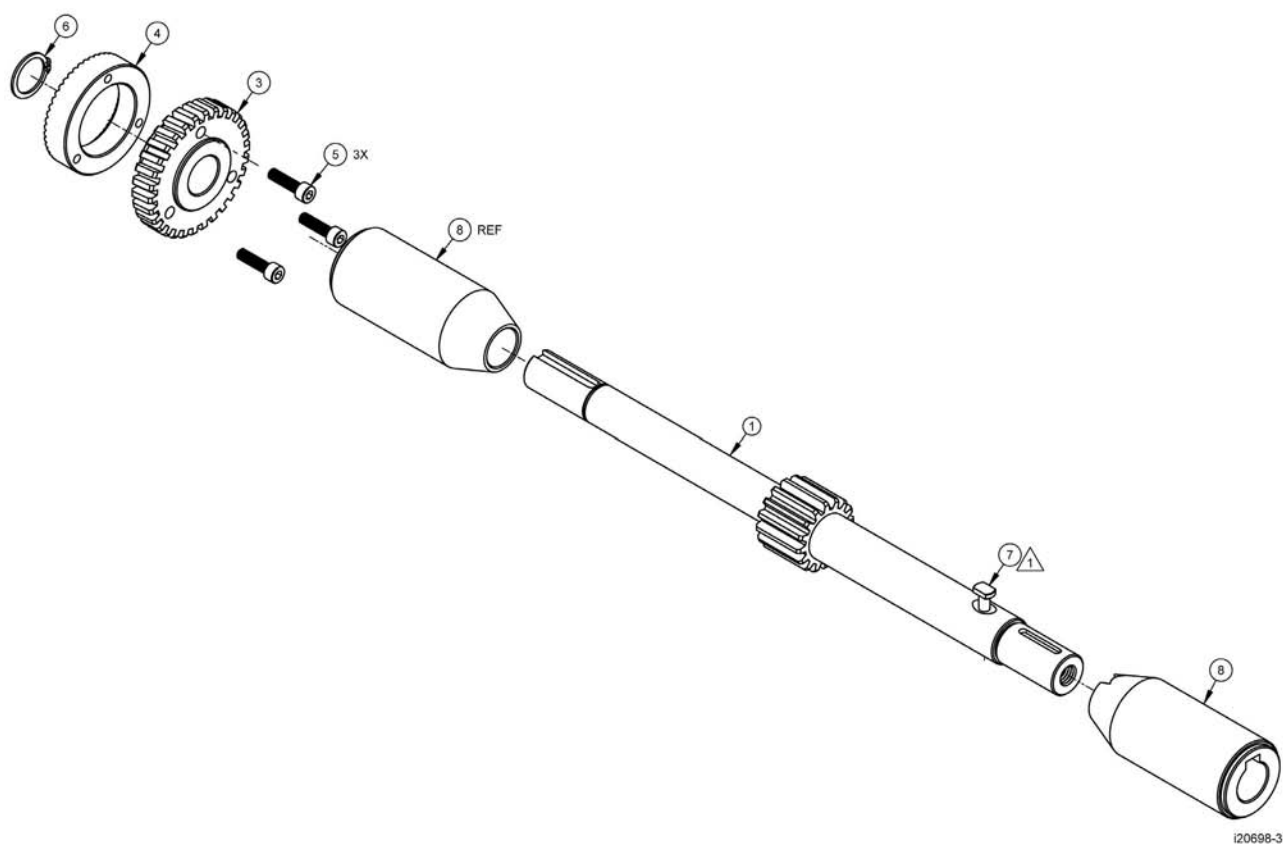


i20698-2

Item	P/N	DESCRIPTION	Qty
1	FB66	CLUSTER GEAR COVER	1
2	FB64	CLUSTER GEAR SHIFT CRANK	1
3	FB69-1	DIAL	1
4	FB69	SHIFT KNOB	1
5	FB71	SPRING	1
6	FB70	STEEL BALL	1
7	FB68	SET SCREW M6-P1.0x8L	1
8	FB63	FEED GEAR SHIFT FORK	1
9	FB60	FEED SHIFT ROD	1
10	FB61	KP.SET SCREW M5-P0.8x6L	1

i00604-K4

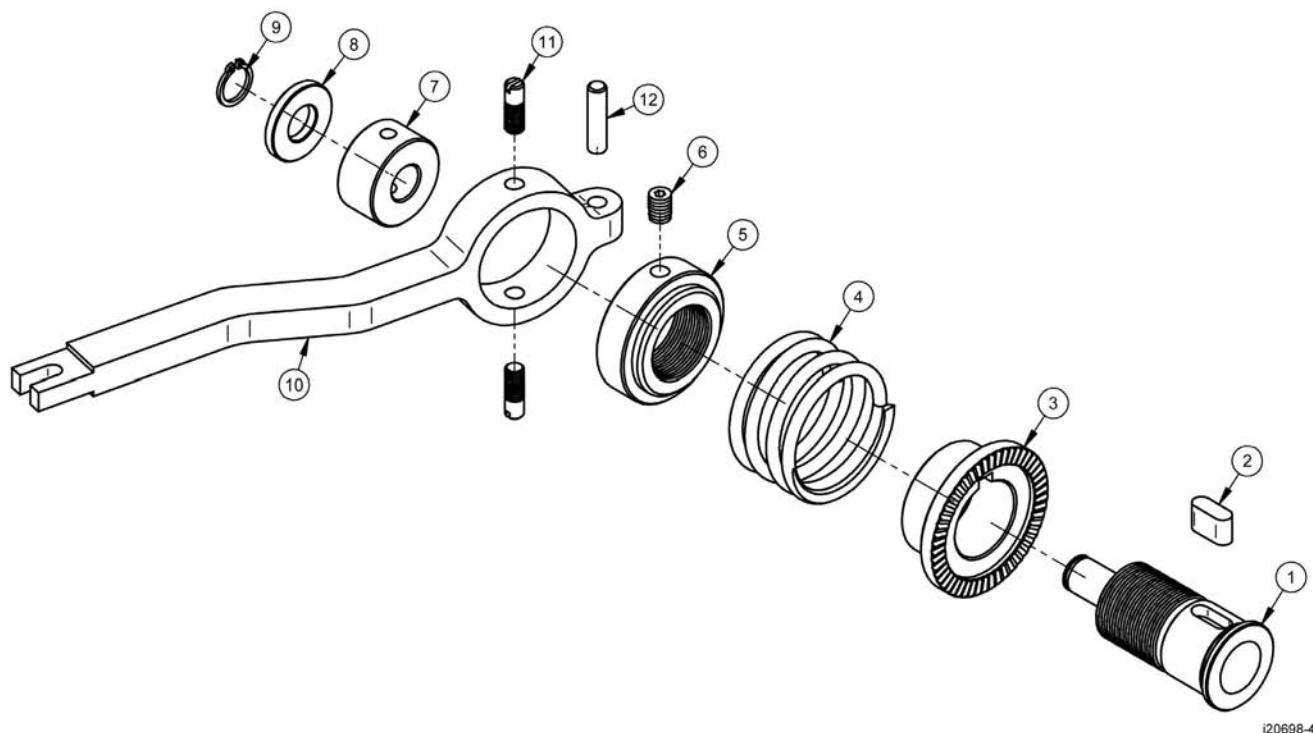
Figure 111
Quill Feed Selector Sub-Assembly
P/N: 20698-2



Item	P/N	Title	UseAs	Qty
1	FB166	QUILL PINION SHAFT	EA	1
3	K-B92	OVERLOAD CLUTCH WORM GEAR	EA	1
4	K-B93	OVERLOAD CLUTCH RING	EA	1
5	K-B92-1	SCREW SOC HD CAP M4-P0.7x15L	EA	3
6	K-B94	SNAP RING 95 DOWEL PIN Ø 14	EA	1
7	K-B168	SCREW PIN	EA	(1)
8	25707	BUSHING KIT-PINION SHAFT-40 TAPER	EA	1

i20698-3

Figure 112
Quill Pinion Shaft Sub-Assembly
P/N: 20698-3

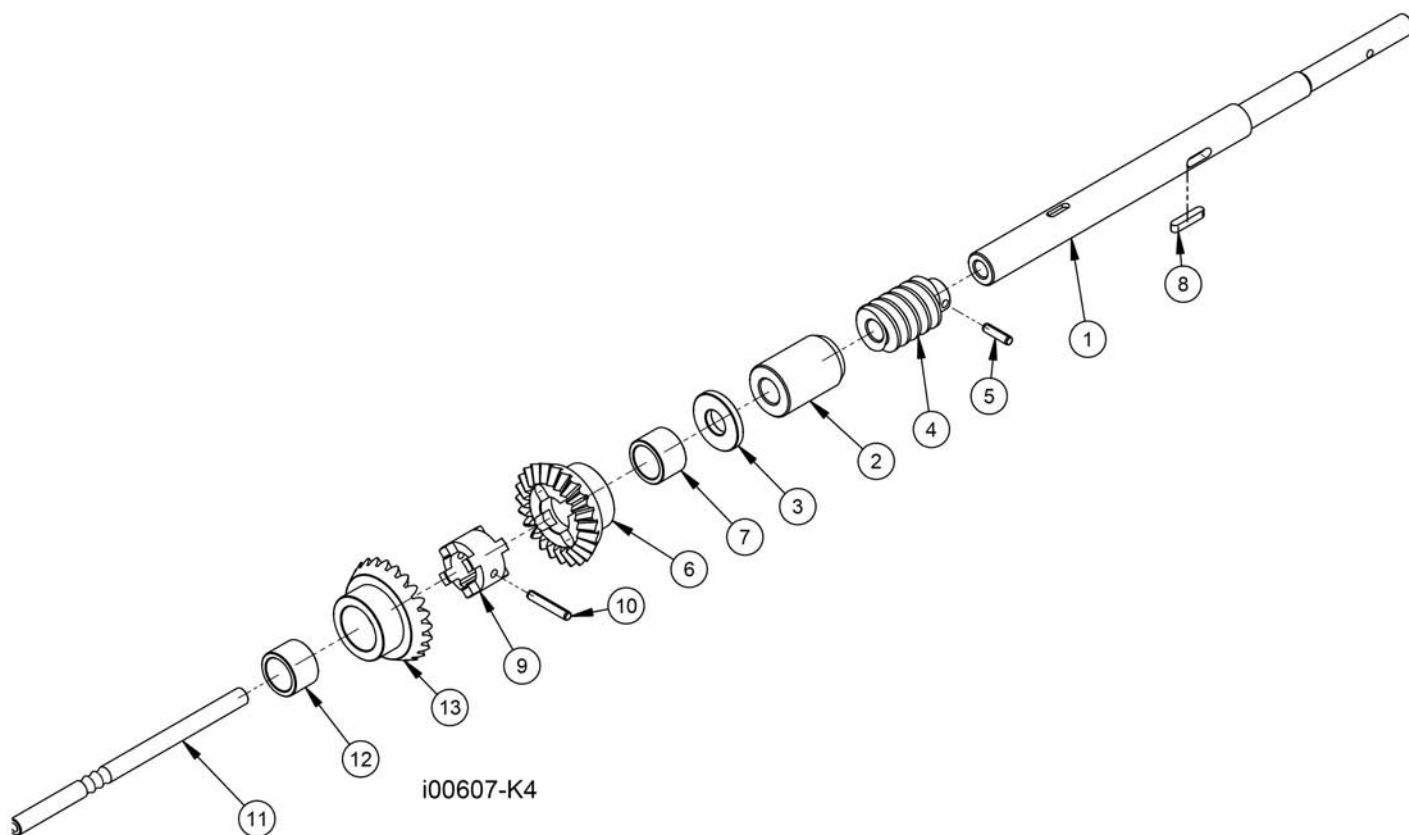


i20698-4

Item	P/N	Title	Qty
1	FB81	OVERLOAD CLUTCH SLEEVE	1
2	FB81-1	KEY 5x8x13L	1
3	FB80	OVERLOAD CLUTCH	1
4	FB79	SAFETY CLUTCH SPRING	1
5	FB78	OVERLOAD CLUTCH LOCKNUT	1
6	FB76	SOCKET SET SCREW M6-P1.0x8L	1
7	FB75	CLUTCH RING	1
8	FB97	OVERLOAD CLUTCH WASHER	1
9	FB98	SNAP RING Ø 10	1
10	FB96	OVERLOAD CLUTCH TRIP LEVER	1
11	FB74	CLUTCH RING PIN (2REQ.)	2
12	FB77	BRASS PLUG	1

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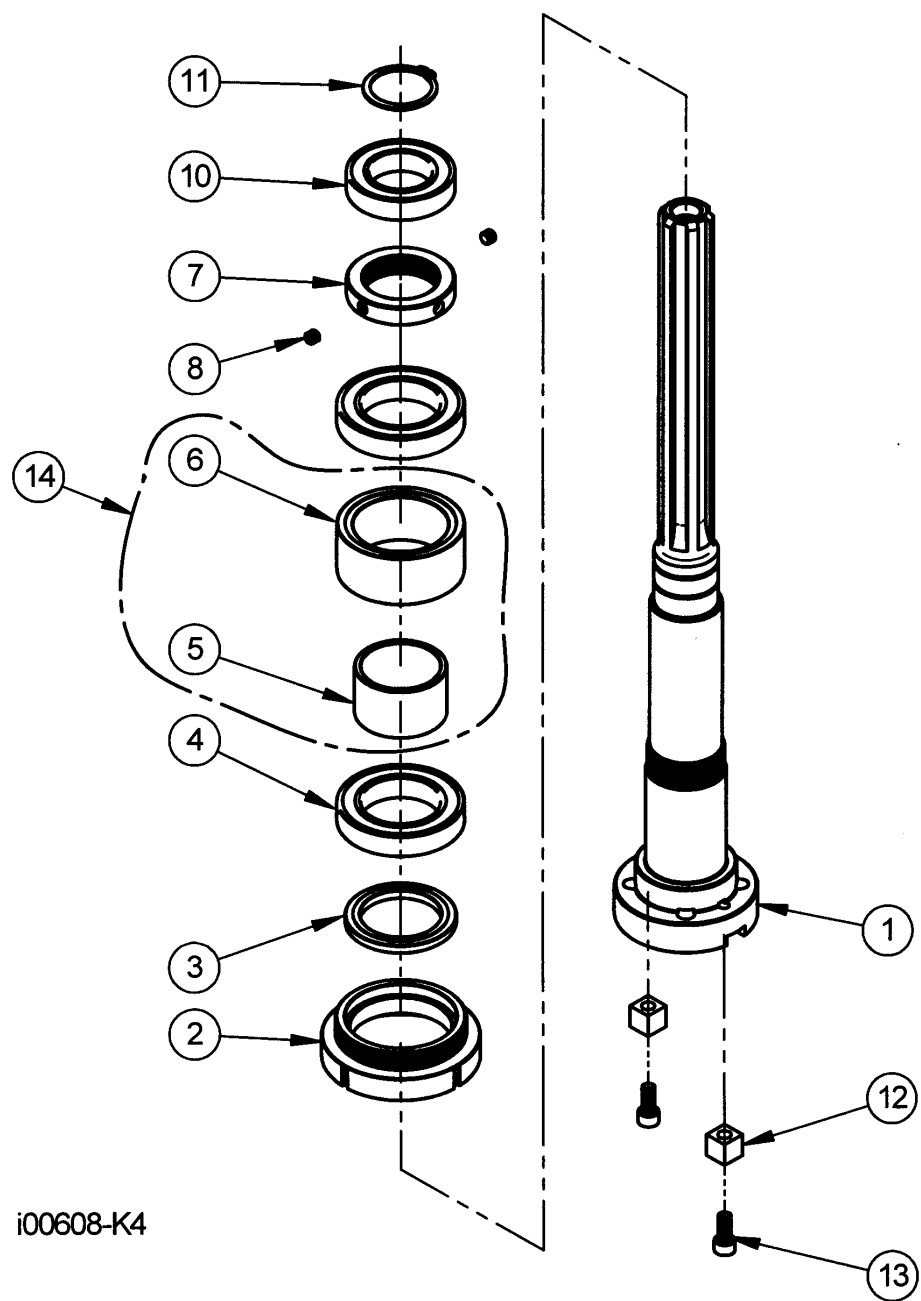
Figure 113
Overload Clutch Trip Sub-Assembly
P/N: 20698-4



Item	P/N	Title	Qty
1	FB57	FEED WORM SHAFT	1
2	FB44	FEED WORM SHAFT BUSHING	1
3	FB47	FEED WORM SHAFT THRUST WASHER	1
4	FB43	WORM	1
5	FB59	PIN Ø 3x12L	1
6	FB49	FEED REVERSE BEVEL GEAR	1
7	FB48	BUSHING	1
8	FB62	KEY 3x3x15L	1
9	FB50	FEED REVERSE CLUTCH	1
10	FB50-1	PIN Ø 3x19L	1
11	FB55	REVERSE CLUTCH ROD	1
12	FB52	BUSHING	1
13	FB51	FEED REVERSE BEVEL GEAR	1

i00607-K4

Figure 114
Feed Reverse Clutch Sub-Assembly
P/N: 20698-5



i00608-K4

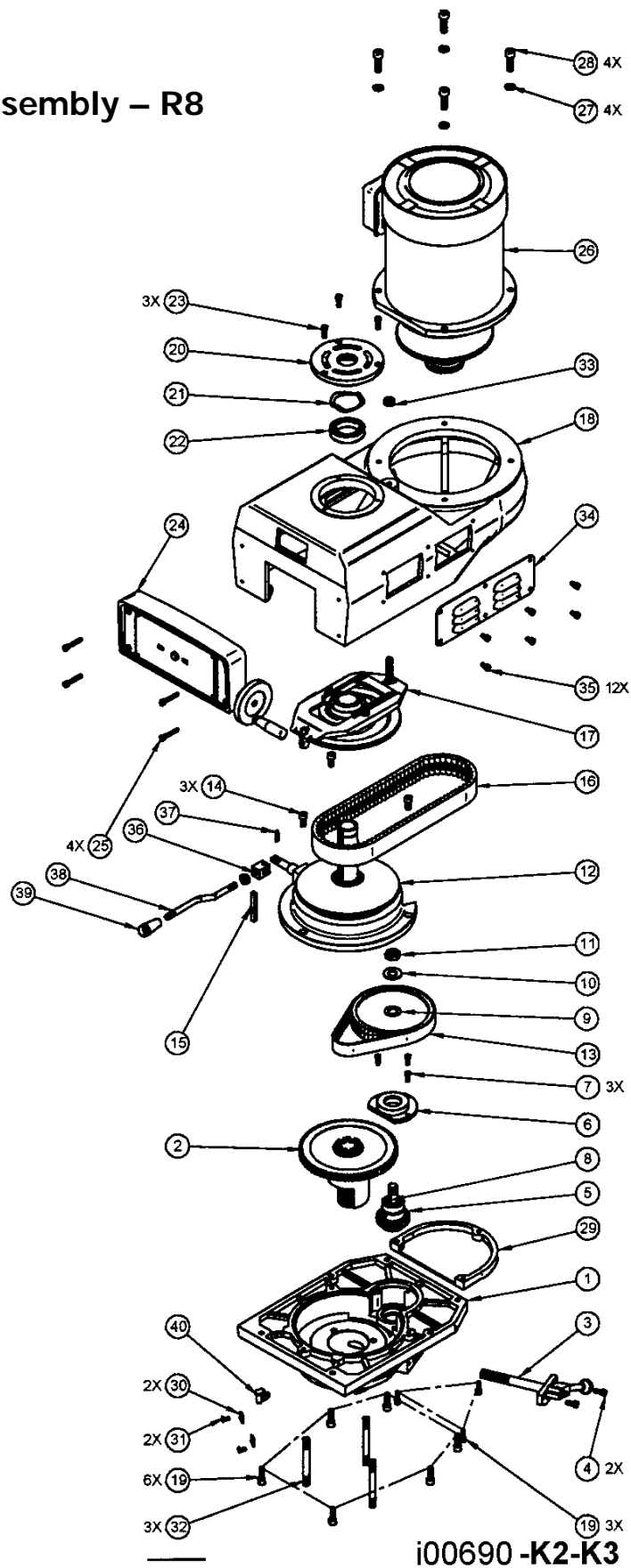
Figure 115
Quill Spindle Sub-Assembly
P/N: 20836-1

Parts List - Spindle Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FB127	SPINDLE BT-40	1
2	FB133	NOSE-PIECE	1
3	FB134	SPINDLE DIRT SHIELD	1
4	20839	BEARING-ANGULAR CONTACT U/ SET (2)-7010 P4	1 Set
5	FB136	BEARING SPACER-LARGE	1
6	FB137	BEARING SPACER-SMALL	1
7	FB139	SPINDLE BEARING KNOCK NUT	1
8	FB139-1	SET SCREW M8-P1.25x6L	2
10	A112H	BEARING 6008ZZ	1
11	FB143	LOCK RING Ø 40	1
12	FB140	SPINDLE FIXED NUT	2
13	FB141	COLLET ALIGNMENT SCREW M8-P1.25x20L	2
14	20841	BEARING SPACER SET	1

i00608-K4

Figure 118
Top Housing Assembly – R8

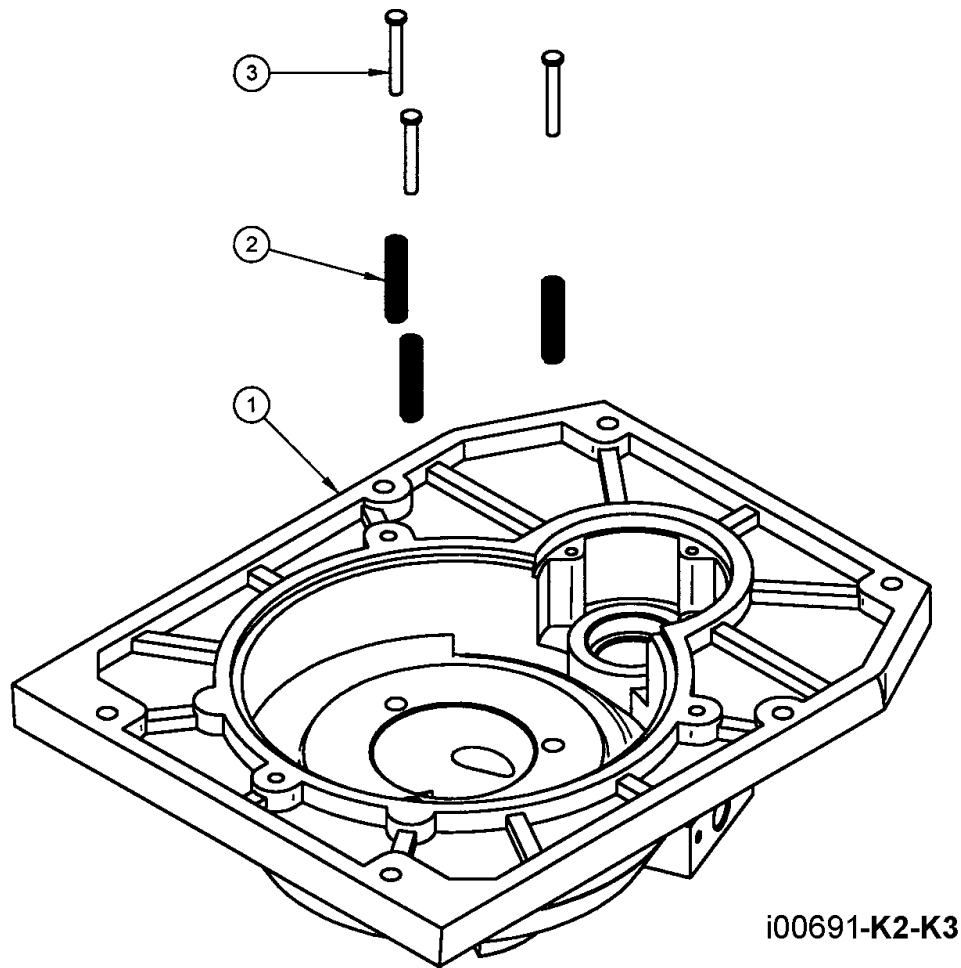


Parts List

Head Top Assembly - 24692

Item	P/N	Title	Qty
1	20778-1	GEAR HOUSING SUB-ASSY (3VK-A1)	1
2	20778-2	HI-LOW SHIFT CLUTCH SUB-ASSY (3VK-A2)	1
3	20778-3	HI-LOW SHIFT SUB-ASSY (3VK-A3)	1
4	VS12	SOCKET CAP SCREW M6-P1.0x15L	2
5	20778-4	PULLY PINION SUB-ASSY (3VK-A4)	1
6	VS64	BULL GEAR PINION BEARING CAP	1
7	VS93	SCREW M5-P0.8x15L	1
8	VS117	KEY 5x525L	1
9	VS62	TIMING BELT PULLEY	1
10	VS126	WASHER Ø 5/8	1
11	VS61	JAM NUT 5/8-11NC	1
12	20778-5	LOWER VARI-DISC DRIVE SUB-ASSY (3VK-A5)	1
13	VS63	BELT 3/8"-#225	1
14	VS14-1	SCREW M8-P1.25x18L	3
15	VS135	KEY 8x7x60L	1
16	VS4	BELT	1
17	20778-6	UPPER VARI-DISC DRIVE SUB-ASSY (3VK-A6)	1
18	VS1	BELT HOUSING	1
19	VS137	SOCKET CAP SCREW M8-P1.25x25L	1
20	VS13	TOP BEARING CAP	1
21	VS13-1	WAVE WASHER	1
22	VS15	BEARING-DEEP GROVE-6007V	1
23	VS129	SCREW- SOC HD CAP M6-P1.0x18L	1
24	20778-7	SPEED CHANGE HANDWHEEL SUB-ASSY (3VK-A7)	1
25	VS07	SCREW- SOC HD CAP M6-P1.0x35L	1
26	20819-1	MOTOR ASSY- K2 & K3- 3HP WHITE (reference only, not part of upper head housing assembly)	1
27	VS130	WASHER- FLAT Ø 10.2	4
28	VS111	SOC HD SCREW- 3/8-16NCx32L	4
29	VS11	MOTOR PULLEY COVER	1
30	VS104	COPPER CHIP(2REQ.)	2
31	VS131	SCREW- FLAT HD PHILIP M5-P0.8x10L	1
32	VS132	STUD Ø 7/16-100L	2
33	VS96	JAM NUT 3/8"-16NC	1
34	VS101	VENTILATOR(2REQ.)	2
35	VS136	SCREW- SOC HD CAP M6-P1.0x10L	12
36	VS54	HANDLE FIX BLOCK	1
37	VS55	SET SCREW	1
38	VS56	BRAKE LOCK HANDLE	1
39	VS57	BAKELITE BALL HANDLE	1
40	OIL-1	OIL CUP	1

i00690-K2-K3



Item	P/N	Title	Qty
1	VS82	GEAR HOUSING	1
2	VS112	GUIDE SPRING	3
3	VS113	SPRING GUIDE PIN	3

i00691-K2-K3

Figure 119
Gear Housing
P/N: 20778-1

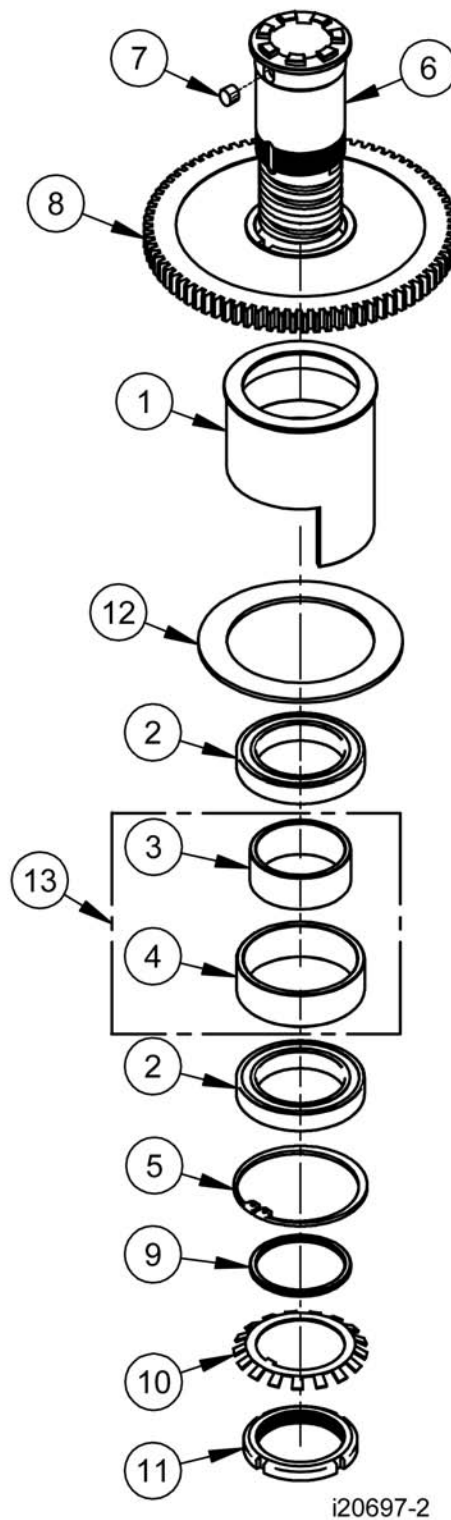


Figure 120
Hi-Low Shift Clutch
Sub-Assembly
P/N: 20778-2

Parts List – High-Low Shift Clutch

Item	P/N	DESCRIPTION	Qty
1	VS75	BEARING SLIDING HOUSING	1
2	23970	BALL BEARING 6908ZZ	1 SET
3	VS78	BEARING SPACER	1
4	VS79	BEARING SPACER	1
5	VS80	SNAP RING R-65	1
6	VS73	SPLINED GEAR HUB	1
7	VS72	KEY 8x7x10L	1
8	VS74	SPINDLE BULL GEAR	1
9	VS114	WASHER	1
10	VS115	EXTERNAL TOOTH WASHER Ø 40	1
11	VS81	LOCK WASHER Ø 9/16-18NC	1
12	VS76	RING	1
13	20817	SPACER-BEARING	1

i00692-K2-K3

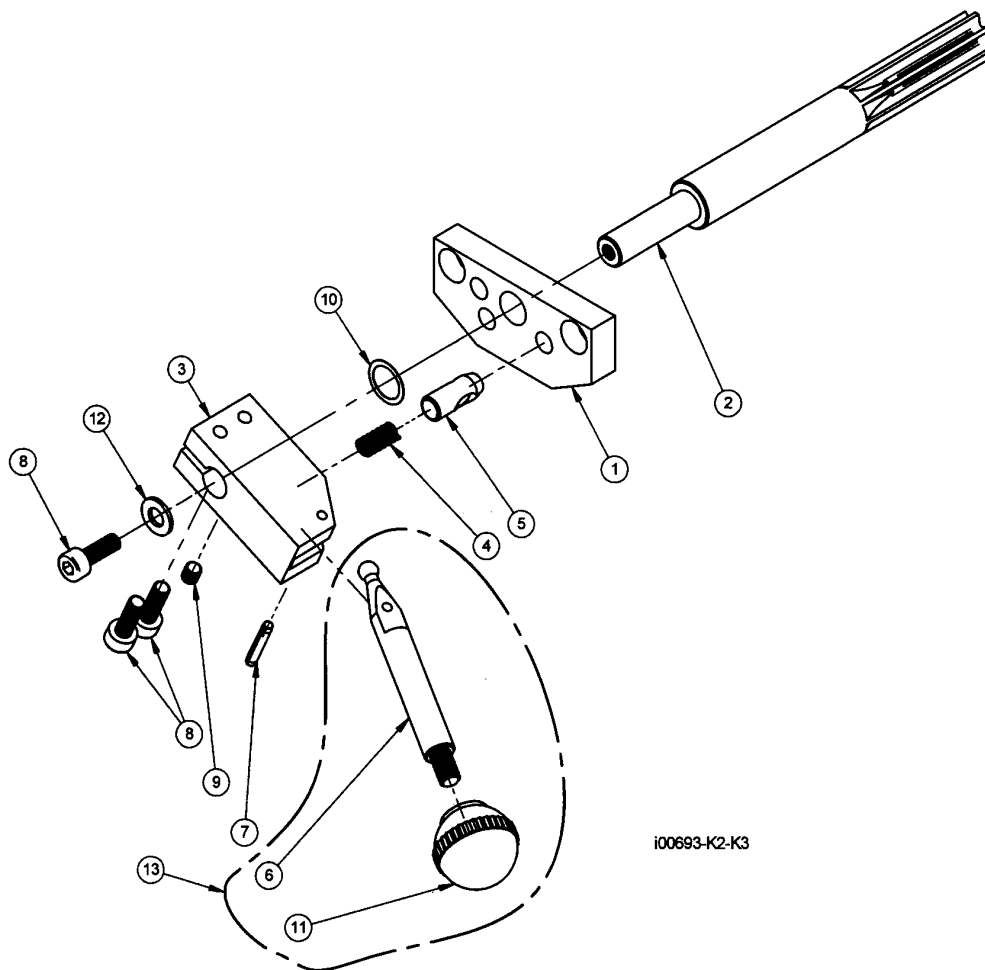
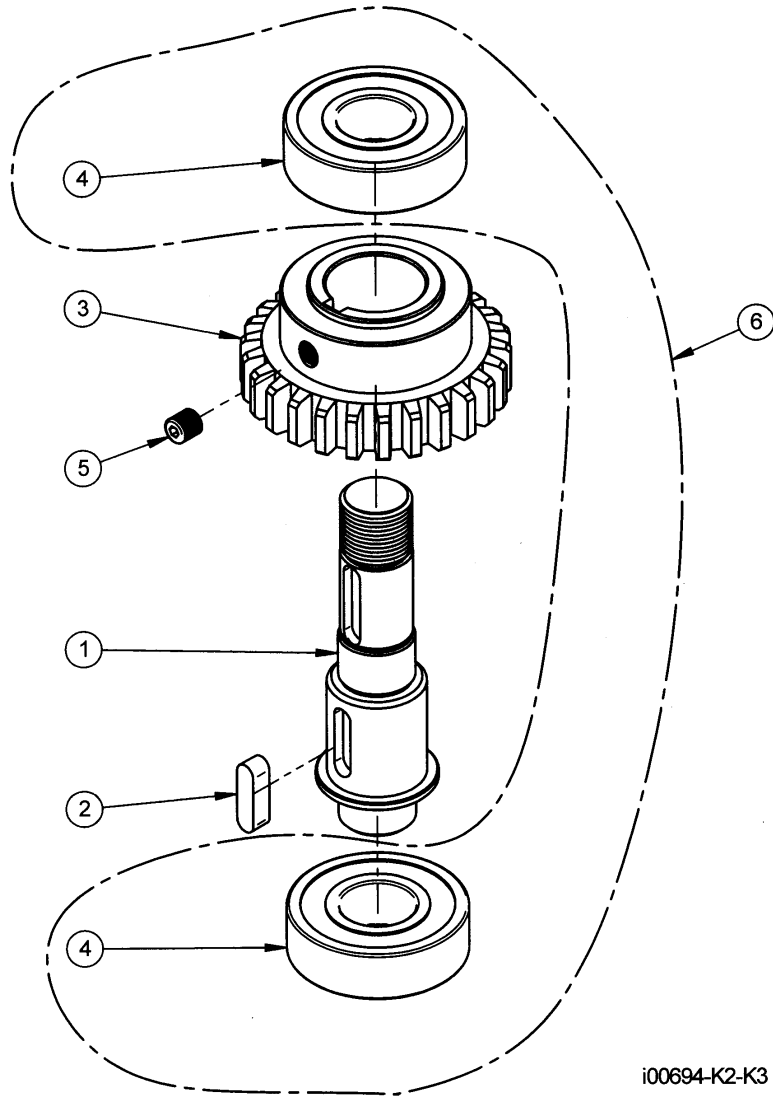


Figure 121
Hi-Low Shift
P/N: 20778-3

Item	P/N	DESCRIPTION	Qty
1	VS89	HI-LOW DETENT PLATE	1
2	VS87	CLUTCH GEAR SHAFT	1
3	VS92	HI-LOW PINION BLOCK	1
4	VS91	SPRING	1
5	VS90	HI-LOW DETENT PLUNGER	1
7	VS88	PIN Ø 3X19L	1
8	VS93	SCREW M5-P0.8x15L	2
9	VS92-1	SET SCREW M5-P0.8x5L	1
10	VS92-2	WASHER- FLAT Ø 11	1
12	VS116	WASHER- FLAT Ø M5	1
13	24083	SHAFT-HI/LOW SHAFT ASSY	1

i00693-K2-K3



Item	P/N	DESCRIPTION	Qty
1	VS67	BULL GEAR PINION COUNTER SHAFT	1
2	VS69	KEY 5X5X18L	1
3	VS66	BULL GEAR PINION	1
4	AK118	BEARING-DEEP GROOVE-6203ZZ	2
5	VS3	SOCKET SET SCREW M6-P1.0x6L	1
6	23954	BEARING SET (2) BEARING 6203ZZ	1

i00694-K2-K3

Figure 122
Pulley Pinion
P/N: 20778-4

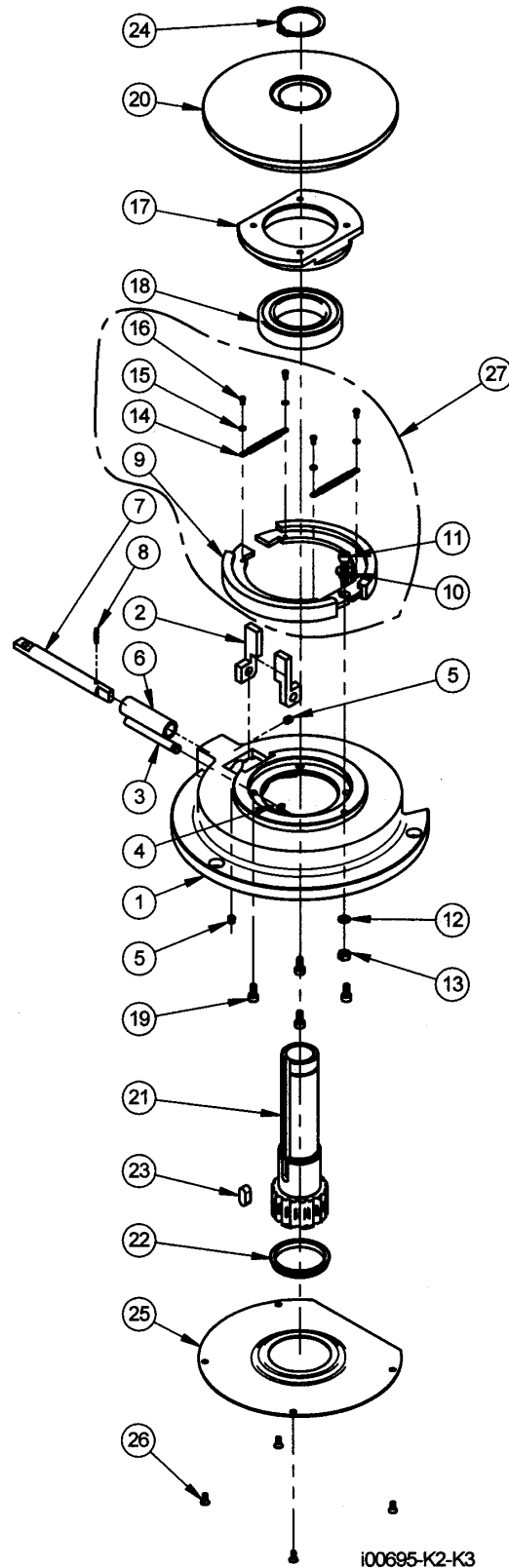


Figure 123
Lower Vari-Disc Drive
P/N: 20778-5

(assembly not available, order parts separately)

Parts List – Lower Vari-Disc Drive

Item	P/N	DESCRIPTION	Qty
1	VS50	BELT HOUSING BASE	1
2	VS59	BRAKE BLOCK	2
3	VS58	TURNING BLOCK SHAFT	1
4	VS103	RETAINING RING Ø 7	1
5	VS51	SET SCREW M6-1.0X6L	2
6	VS53	BRAKE LOCK BUSHING	1
7	VS52	BRAKE LOCK SHAFT	1
8	VS52-2	BRAKE LOCK PIN DIA 3 X 5/8"L	1
9	VS47	BRAKE SHOE	2
10	VS48	BRAKE SHOE PIVOT SLEEVE	1
11	VS17	SOCKET CAP SCREW M6-P1.0x35L	1
12	VS17-1	WASHER Ø 6	1
13	VS17-2	NUT M6-P1.0	1
14	VS49	BRAKE SPRING	2
15	VS122	WASHER DIA 3.3	4
16	VS120	SCREW-PAN HEAD PHILIP 5-40NC	4
17	VS46	BRAKE BEARING CAP	1
18	VS43-1	BALL BEARING 6010ZZ	1
19	VS14	SOCKET CAP SCREW M5-0.8x12L	4
20	VS45	STATIONARY DRIVEN VARIDISC	1
21	VS70	SPINDLE PULLEY ASSY	1
22	VS100	SPINDLE PULLEY SPACER	1
23	VS71	KEY 8x7x20L	1
24	VS97	SNAP RING Ø 40	1
25	VS50-1	DUST COVER	1
26	VS50-2	SCREW-FH-PH-STL-BO M6-1.0X6L	4
27	24055	BRAKE SHOE ASSY	1

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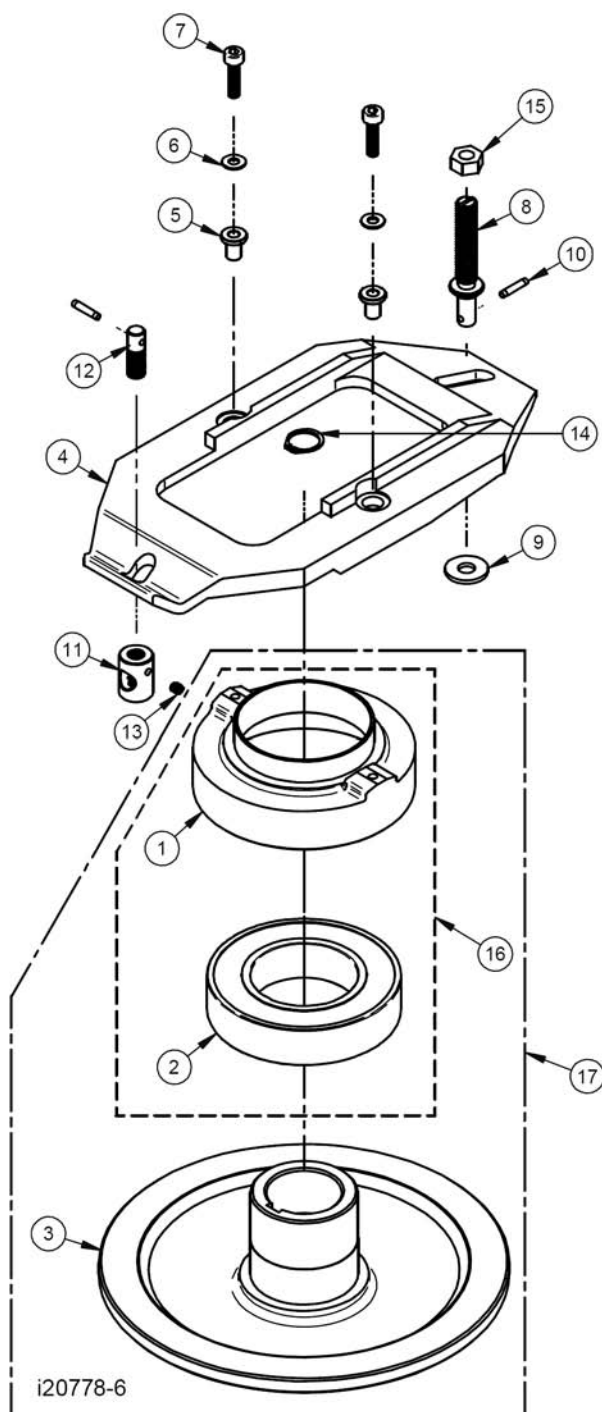
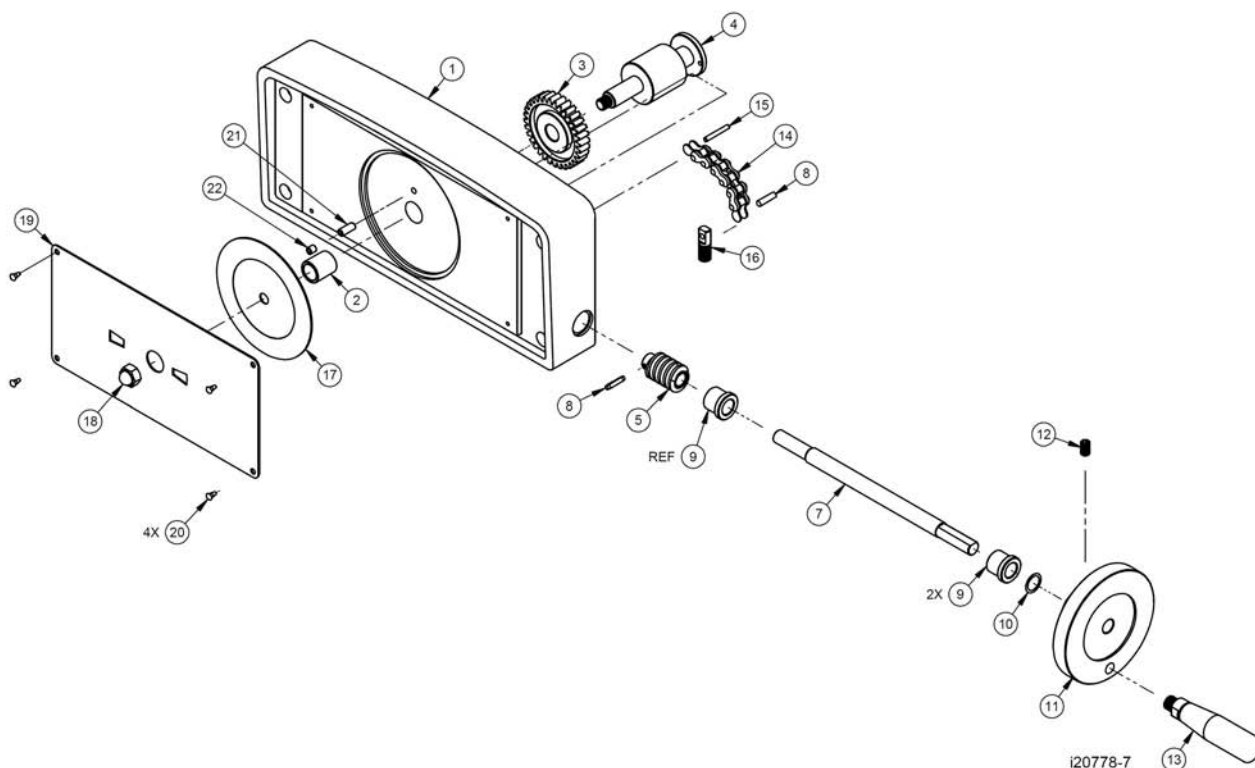


Figure 124
Upper Vari-Disc Drive Sub-Assy
P/N: 20778-6

Parts List – Upper Vari-Disc Drive Sub-Assy

Item	P/N	DESCRIPTION	Qty
1	VS42	SPINDLE PULLEY BEARING HOUSING	1
2	VS43	BEARING-DEEP GROVE-6210ZZ	1
3	VS44	ADJUSTABLE-DRIVEN VARIDISC	1
4	VS36	SPEED CHANGE PLATE	1
5	VS38	PIVOT SLEEVE Ø 5	2
6	VS37	WASHER M5-P0.8x20L	2
7	VS123	SCREW-SHCS M5-0.8X20L	2
8	VS39	SPEED CHANGE PLATE PIVOT STUD	1
9	VS41	WASHER Ø 8.2	1
10	VS40	ROLL PIN Ø3x15L	2
11	VS35	ADJUSTMENT NUT	1
12	VS34	CHAIN END STUD	1
13	VS33	CHAIN FRONT SCREW M4-P0.7x5L	1
14	VS7	SNAP RING Ø 35	1
15	FVS96	JAM NUT 3/8-16NC	1
16	24564	BEARING HOUSING ASSY	1
17	24631	VARI DISC ADJUSTABLE ASSY	1

i20778-6



Item	P/N	DESCRIPTION	Qty
1	VS16	SPEED CHANGE HOUSING	1
2	VS20	BEARING SELF LUBRICATING	1
3	VS22	SPEED CHANGER GEAR	1
4	VS31	SPEED CHANGE CHAIN DRUM	1
5	VS21	WORM	1
7	VS25	SPEED CHANGE SHAFT	1
8	VS40	ROLL PIN Ø3x15L	2
9	VS24	COPPER BUSHING	2
10	VS24-1	WASHER-WAVE	1
11	VS27	SPEED CHANGE HANDWHEEL	1
12	VS18	FULL DOG SOCKET SET SCREW M6-P1.0x10L	1
13	VS28	HANDLE 3/8-16NC	1
14	VS32	CHAIN #310X9.525	1
15	VS31-1	DOWEL PIN Ø3x25L	1
16	VS30	SPEED CHANGE STUD	1
17	VS16-1	SPEED DIAL	1
18	VS95	NUT-ACORN 5/16-18 NC	1
19	VS16-2	NAME PLATE	1
20	VS19	SCREW-DRIVE	4
21	M5-0.8X14 40B	SCREW-SOC SET-STL-BO-CUP	1
22	M5-0.8X5 40B	SCREW-SOC SET-STL-BO-CUP	1

i20778-7

Figure 125
Speed Change Handwheel
P/N: 20778-7

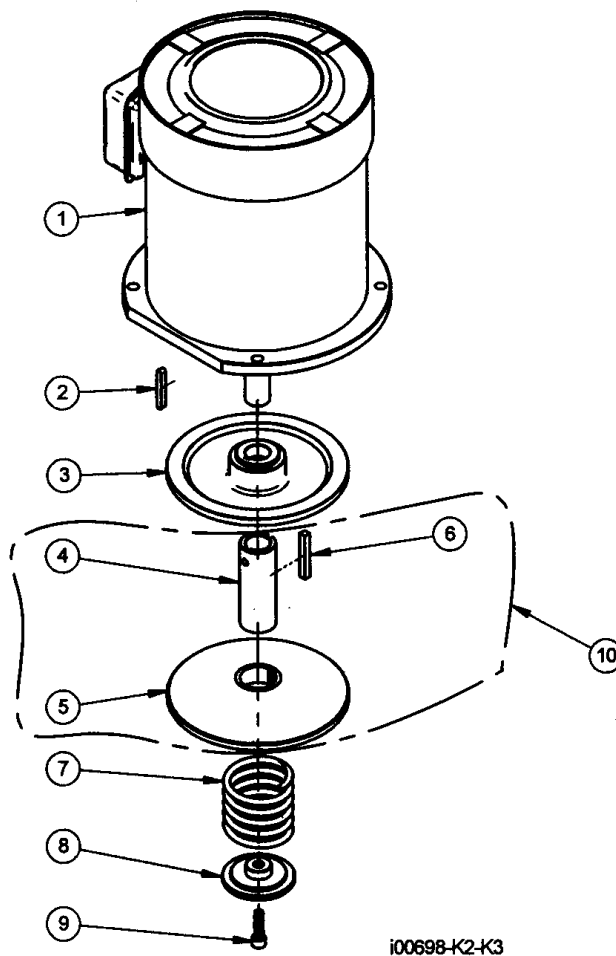


Figure 126
Spindle Motor
P/N: 20819-1

Item	P/N	DESCRIPTION	Qty	Notes
1	VS110	MOTOR 3 HP	1	only available as 20819-1
2	VS3-1	KEY 6x6x45L	1	only available as 20819-1
3	VS2	STATIONARY MOTOR VARIDISC	1	only available as 20819-1
4	VS6	BUSHING	1	available as 23953 or 20819-1
5	VS5	ADJUSTABLE MOTOR VARIDISC	1	available as 23953 or 20819-1
6	VS6-1	KEY 7x7x50L	1	available as 23953 or 20819-1
7	VS8	SPRING FOR VARIDISC MOTOR SHAFT	1	only available as 20819-1
8	VS9	ADJUSTABLE VARIDISC SPRING COLLAR	1	only available as 20819-1
9	VS10	SCREW- SOC HD CAP M8-P1.25x30L	1	only available as 20819-1
10	23953	VARIDISC ASSY-ADJUSTABLE MOTOR	1	

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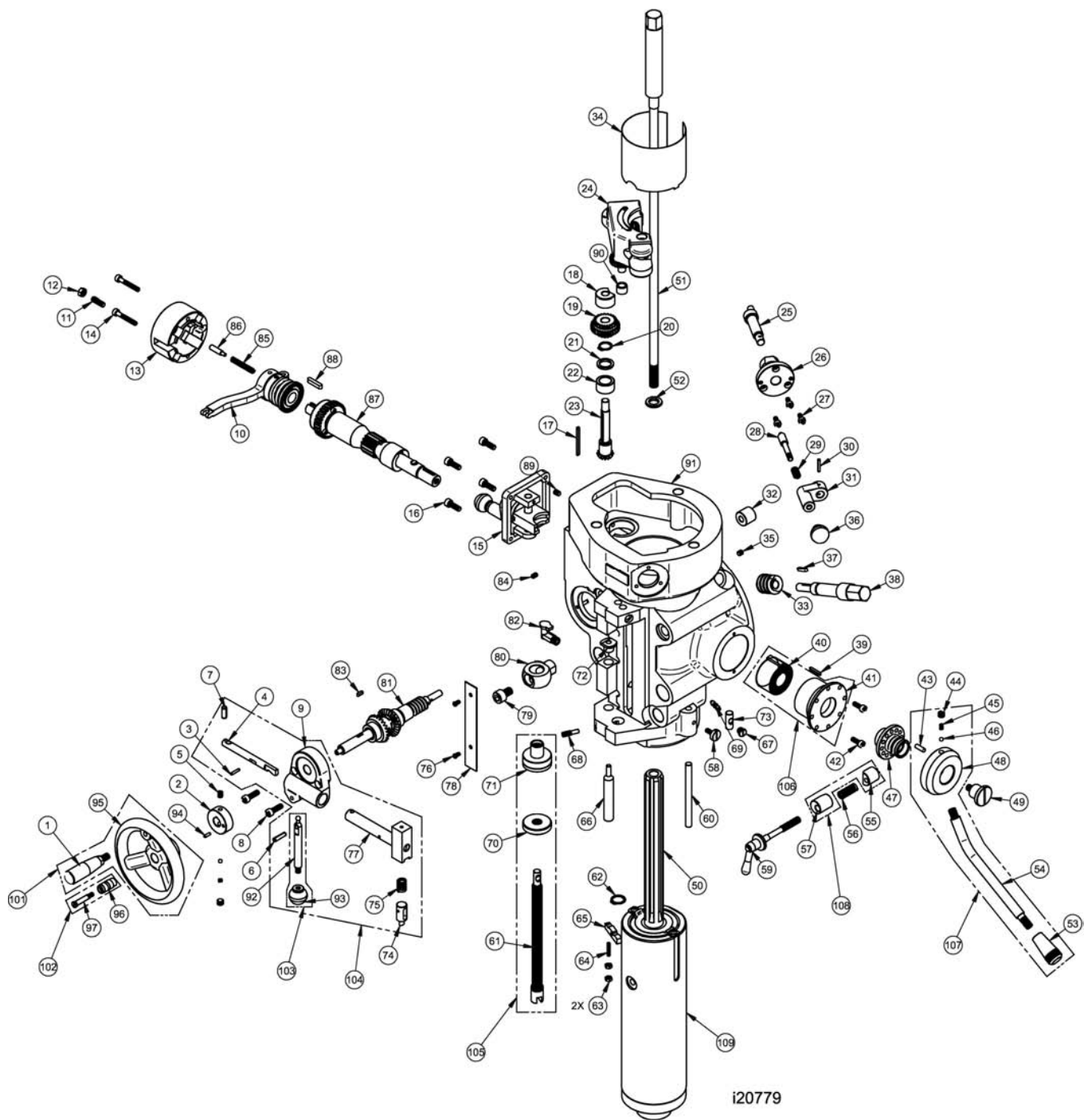


Figure 127
Lower Head Assembly

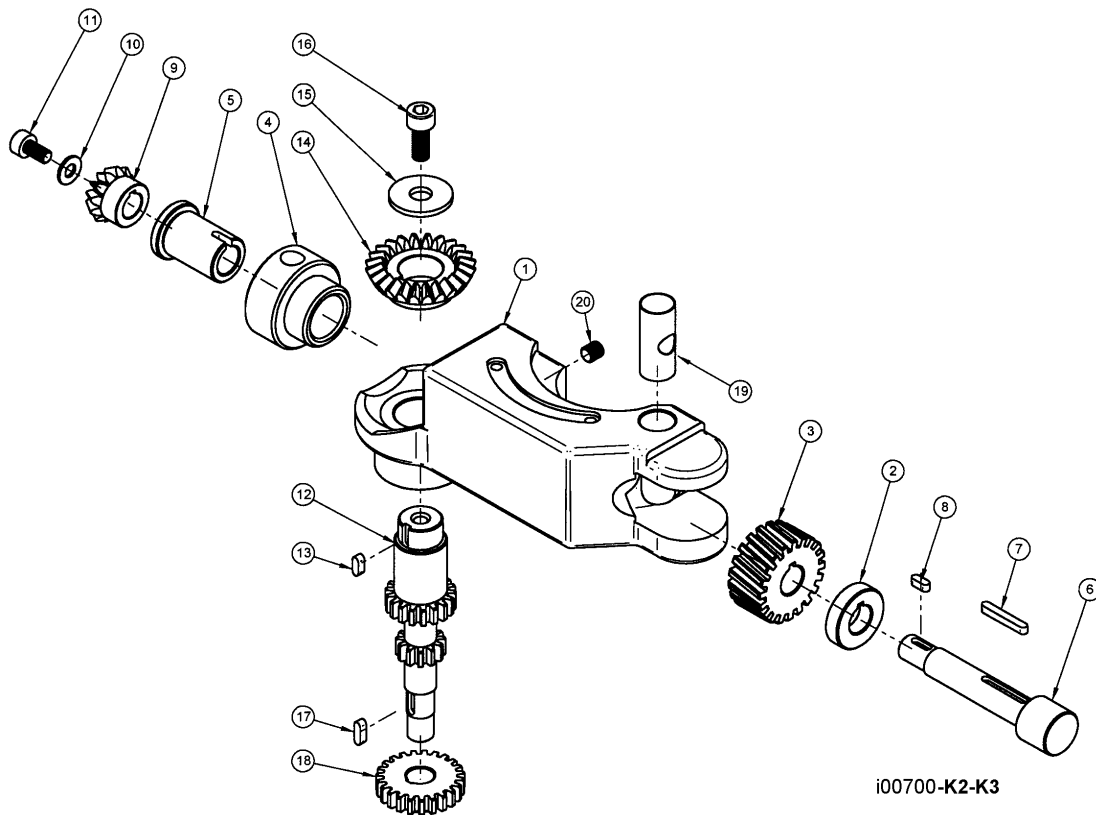
Parts List – Lower Head Assembly

Item	P/N	Title	Qty
1	K-B125-2	HANDWHEEL HANDLE (AVAILABLE ONLY IN ASSY. 20835)	1
2	K-B113	HAND WHEEL CLUTCH	1
3	K-B117	ROLL PIN Ø3x15L	1
4	K-B103	CAM ROD	1
5	K-B108	SOCKET SET SCREW M6-P1.0x8L	1
6	K-B119-1	ROLL PIN Ø3x20L	1
7	K-B103-1	CAM ROD PIN Ø6x15L	1
8	K-B107	CAP SCREW M6-P1.0x25L	2
9	K-B106	FEED TRIP BRACKET	1
10	20779-4	OVERLOAD CLUTCH TRIP SUB-ASSY (3VK-B4)	1
11	K-B73	SOCKET SET SCREW M6-P1.0x20L	1
12	K-B101	CHEM BLACKED LOCKNUT M6-P1.0	1
13	K-B99	CLUTCH ARM COVER	1
15	20779-2	QUILL FEED SELECTOR SUB-ASSY (3VK-B2)	1
16	K-B67	CAP SCREW M6-P1.0x18L	4
17	K-B29	CLUSTER GEAR KEY 3x3x45L	1
18	K-B27	CLUSTER GEAR SHAFT UPPER BEARING	1
19	K-B28	CLUSTER GEARS ASSEMBLY	1
20	K-B94	SNAP RING 95 DOWEL PIN Ø 14	1
21	K-B32	BEVEL GEAR THRUST SPACER	1
22	K-B33	BEVEL GEAR BEARING	1
23	K-B31	CLUSTER GEAR SHAFT 6602BB	1
24	20779-1	WORM GEAR CRADLE SUB-ASSY (3VK-B1)	1
25	K-B18	WORM GEAR CRADLE THROW-OUT	1
26	K-B19	SHIFT SLEEVE	1
27	K-B25	CAP SCREW(3REQ.) M5-P0.8x12L	3
28	K-B20	GEAR SHIFT PLUNGER	1
29	K-B21	COMPRESSION SPRING	1
30	K-B22	ROLL PIN Ø3x20L	1
31	K-B23	SHIFT CRANK	1
33	K-B186	WORM GEAR	1
34	K-B128	QUILL SKIRT	1
35	K-B189-1	ADJ WORM SHAFT SET SCREW M6-P1.0x6L	1
36	K-B42	BUSHING	2
37	K-B187	KEY 4x4x18L	1
38	K-B189	ADJ WORM SHAFT	1
39	K-B171	KEY 3x3x20L	1
40	K-B178	CLOCK SPRING(CLOCK SPRING ASSY.)	1
41	K-B177	SPRING COVER	1
42	K-B169	RD.HEAD SCREW(2REQ.) M5-P0.8x15L	2
43	K-B170	ROLL PIN	1
44	K-B175-3	SET SCREW M8-P1.25x6L	2
45	K-B175-2	COMPRESSION SPRING	2
46	K-B175-1	STEEL BALL	2
47	K-B176	PINION SHAFT HUB SLEEVE	1
48	K-B175	RACK FEED HANDLE HUB	1

49	K-B172	PINION SHAFT HUB SEREW	1
50	20836	SPINDLE ASSY-R8	0
51	VS109	DRAWBAR 7/16-20UNF	1
52	VS109-1	SPACER	1
53	K-B191	BLACK PLASTIC BALL HANDLES (sold as assy 20849 only)	1
54	K-B190	PINION SHAFT HUB HANDLE (sold as assy 20849 only)	1
55	K-B148	QUILL LOCK SLEEVE	1
56	K-B148-1	COMPRESSION SPRING	1
57	K-B153	QUILL LOCK SLEEVE TAPPED	1
58	KB-201	INDICATOR ROD SCREW	1
59	K-B149	LOCK HANDLE	1
60	KB-202	INDICATOR ROD	1
61	K-B164	QUILL STOP MICRO-SCREW	1
62	K-B160	SNAP RING Ø16	1
63	K-B124-2	FEED TRIP PLUNGER NUT M40-P0.7	2
64	K-B124-1	FEED TRIP PLUNGER SOC SET SCREW M4-P0.7x20L	1
65	K-B145	FEED TRIP LEVER	1
66	K-B124	FEED TRIP PLUNGER	1
67	K-B185	REVERSE TRIP BALL LEVER SCREW	1
68	K-B144	SOCKET SET SCREW	1
69	K-B183	REVERSE TRIP BALL LEVER	1
70	K-B161	QUILL MICRO-STOP NUT	1
71	K-B162	MICROMETER NUT	1
72	K-B123	TRIP PLUNGER BUSHING	1
73	K-B184	FEED REVERSE TRIP PLUNGER	1
74	K-B121	TRIP PLUNGER	1
75	K-B120	COMPRESSION SPRING	1
76	K-B158	CHEM BLACKED RD.HD.SCREWS(2 REQ.) M5-P0.8x8L	2
77	K-B118	CAM ROD SLEEVE ASSY	1
78	K-B159	MICROMETER SCALE	1
79	KB-200	SCREW- SOC HD 3/8-24NFx15L	1
80	K-B163	QUILL STOP KNOB	1
81	20779-5	FEED REVERSE CLUTCH SUB-ASSY (3VK-B5)	1
82	OIL-1	OIL CUP	1
83	K-B109	KEY 3x3x20L	1
84	K-B17-1	WORM GEAR SET SCREW M6-P1.0x8L	1
85	K-B88-1	COMPRESSION SPRING	1
86	K-B89	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1
87	20779-3	SUB - ASSY - QUILL PINION SHAFT - R8	1
88	K-B167	KEY 5x5x25L	1
89	K-B27-1	SET SCREW M6-P1.0x8L	1
90	K-B41	NEEDLE BEARING BA66 BEARING SIZE KO-BA66Z	1
91	K-B192	QUILL HOUSING	1
92	K-B104	TRIP HANDLE	1
93	K-B105	BLACK PLASTIC BALL	1
94	K-B125-1	HANDWHEEL SPRING PIN Ø3x3x10L	1
95	K-B125	HANDWHEEL	1
96	K-B111	REVERSE KNOB	1
97	K-B100	CAP SET SCREW M5-P0.8x35L	3

98	25042	SCALE-HEAD ROTATION-R8	1
99	25043	POINTER SCALE	1
100	25044	DRIVE SCREW-SCALE	4
101	20835	HANDWHEEL ASSY	1
102	20834	FEED REVERSE KNOB ASSY	1
103	24052	TRIP HANDLE ASSEMBLY (INCLUDES PLASTIC BALL)	1
104	20832	FEED TRIP ASSY	1
105	20847	QUILL MICRO NUT & SCREW ASSY	1
106	24051	CLOCK SPRING ASSEMBLY (SPRING & COVER)	1
107	20849	FEED HANDLE ASSY (QUILL HANDLE)	1
108	20843	QUILL LOCK SLEVE ASSY	1
109	K-B142	QUILL	1
110	K-B155	T BOLT ASSY (not shown on drawing)	1

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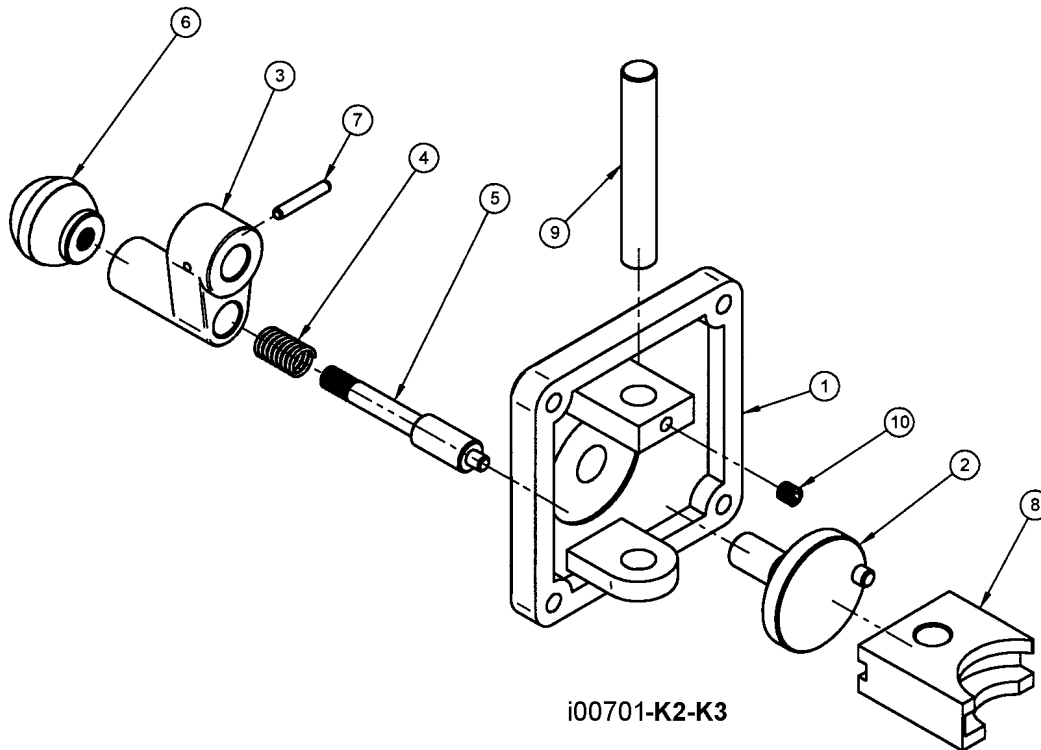


i00700-K2-K3

Item	P/N	Title	Qty
1	K-B17	WORM GEAR CRADLE	1
2	K-B07	WORM GEAR SPACER	1
3	K-B08	FEED DRIVEWORM GEAR	1
4	K-B05	WORM CRADLE BUSHING	1
5	K-B04	FEED WORM GEAR SHAFT SLEEVE	1
6	K-B09	FEED DRIVE WORM GEAR SHAFT	1
7	K-B11	KEY 3x3x25L	1
8	K-B10	WORM SHAFT KEY 3x3x8L	1
9	K-B03	FEED BEVEL PINION	1
10	K-B02	BEVEL PINION WASHER Ø 5	1
11	K-B01	SOC.HD.SCREW M5-P0.8x10L	1
12	K-B36	FEED DRIVING GEAR	1
13	K-B36-1	KEY 3x3x8L	1
14	K-B15	FEED REVERSE BEVEL GEAR	1
15	K-B13	WASHER Ø 6, 22 OD	1
16	K-B14	SOC HD SCREW M6-P1.0x15L	1
17	K-B37	KEY 3x3x10L	1
18	K-B40	FEED DRIVE GEAR	1
19	K-B16	FEED ENGAGE PIN	1
20	K-B06	SETSCREW M6-P1.0x6L	1

i00700-K2-K3

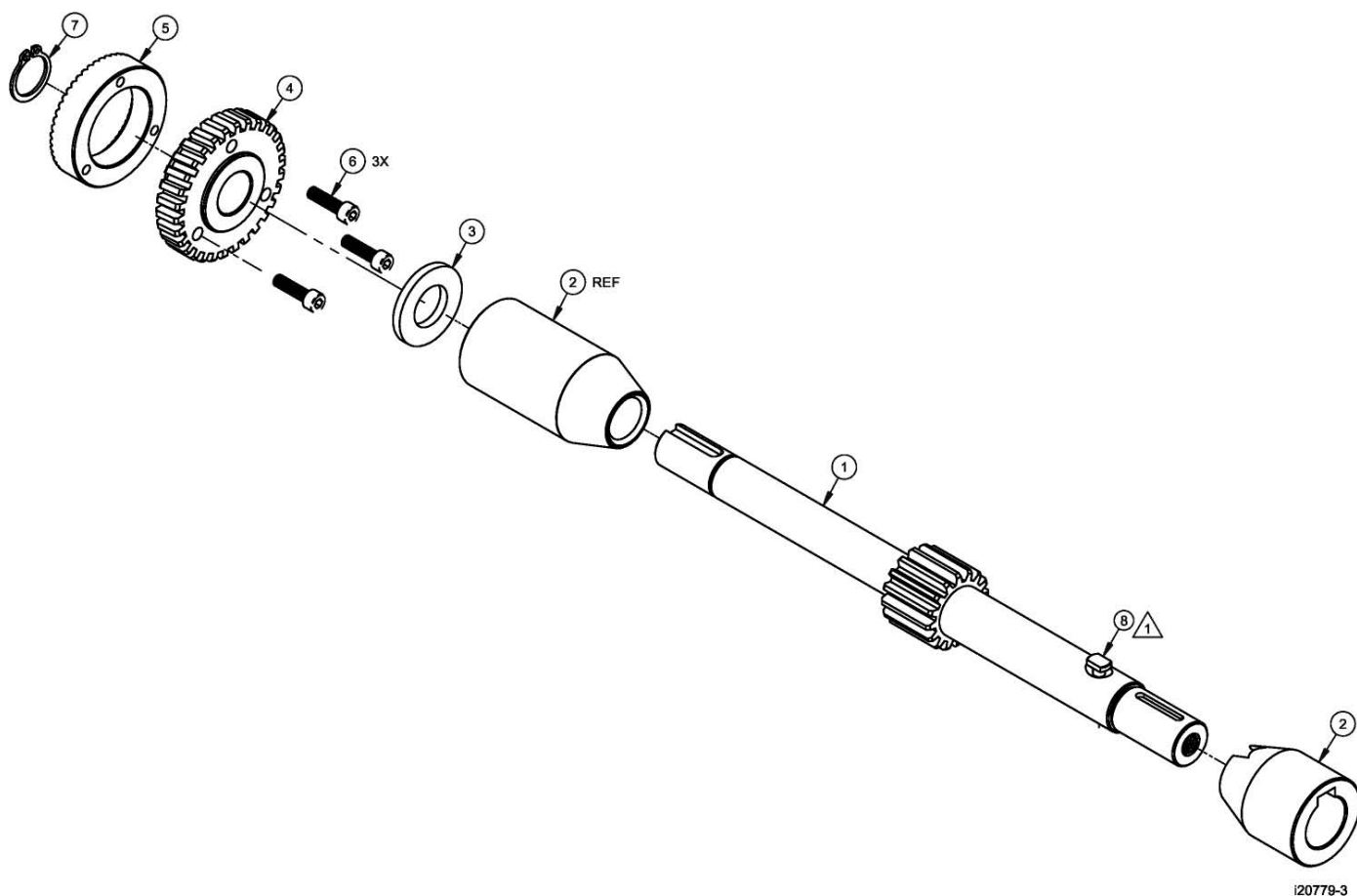
Figure 128
Worm Gear Cradle
P/N: 20779-1



Item	P/N	Title	Qty
1	K-B66	CLUSTER GEAR COVER	1
2	K-B64	CLUSTER GEAR SHAFT CRANK	1
3	K-B70	SHIFT CRANK	1
4	K-B69	SPRING Ø 3 x 20L	1
5	K-B68	GEAR SHIFT PLUNGER	1
6	K-B72	SHIFT KNOB-5/16-18NC	1
7	K-B71	ROLL PIN Ø 3 x 20L	1
8	K-B63	FEED GEAR SHIFT FORK	1
9	K-B65	SHAFT	1
10	K-B61	CAP SET SCREW M5-P0.8x5L	1

i00701-K2-K3

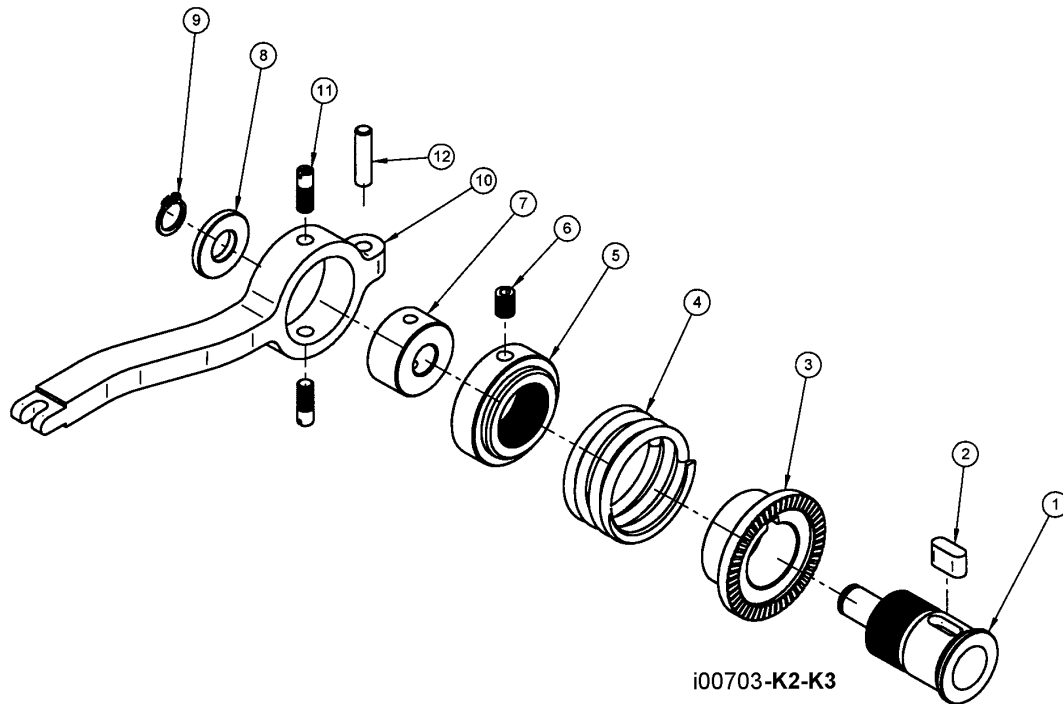
Figure 129
Quill Feed Selector
P/N: 20779-2



Item	P/N	Title	UseAs	Qty
1	K-B166	QUILL PINION SHAFT	EA	1
2	25706	BUSHING KIT-PINION SHAFT-R8	EA	1
3	K-B91	WASHER	EA	1
4	K-B92	OVERLOAD CLUTCH WORM GEAR	EA	1
5	K-B93	OVERLOAD CLUTCH RING	EA	1
6	K-B92-1	SCREW SOC HD CAP M4-P0.7x15L	EA	3
7	K-B94	SNAP RING 95 DOWEL PIN Ø 14	EA	1
8	K-B168	SCREW PIN	EA	(1)

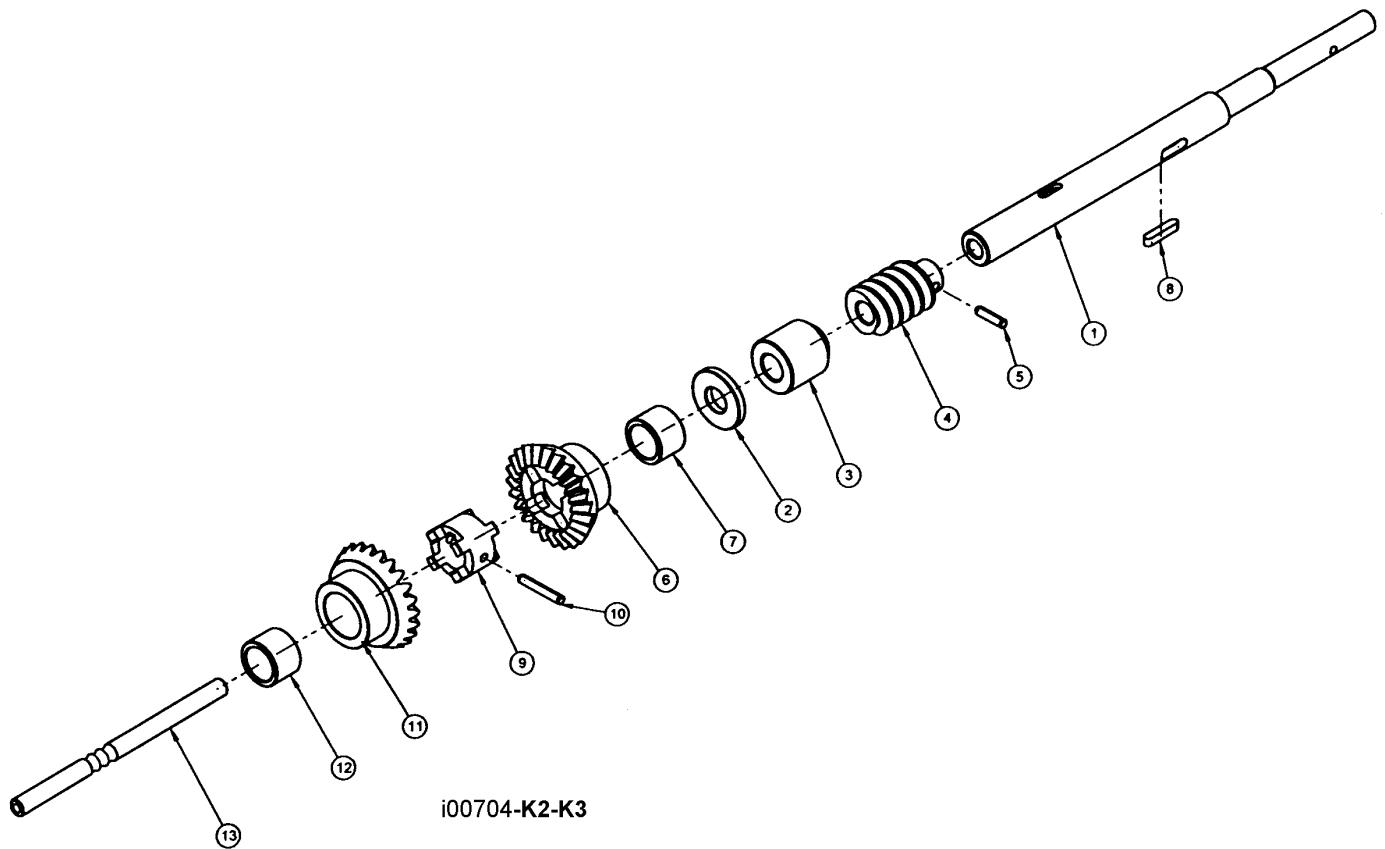
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Figure 130
Quill Pinion Shaft
P/N: 20779-3



Item	P/N	Title	Qty
1	K-B81	OVERLOAD CLUTCH SLEEVE	1
2	K-B81-1	KEY 5x8x13L	1
3	K-B80	OVERLOAD CLUTCH	1
4	K-B79	SAFETY CLUTCH SPRING	1
5	K-B78	OVERLOAD CLUTCH LOCKNUT	1
6	K-B76	SOCKET SET SCREW M6-P1.0x8L	1
7	K-B75	CLUTCH RING	1
8	K-B97	OVERLOAD CLUTCH WASHER	1
9	K-B98	SNAP RING Ø 10	1
10	K-B96	OVERLOAD CLUTCH TRIP LEVER	1
11	K-B74	CLUTCH RING PIN (2REQ.)	2
12	K-B77	BRASS PLUG	1
i00703-K2-K3			

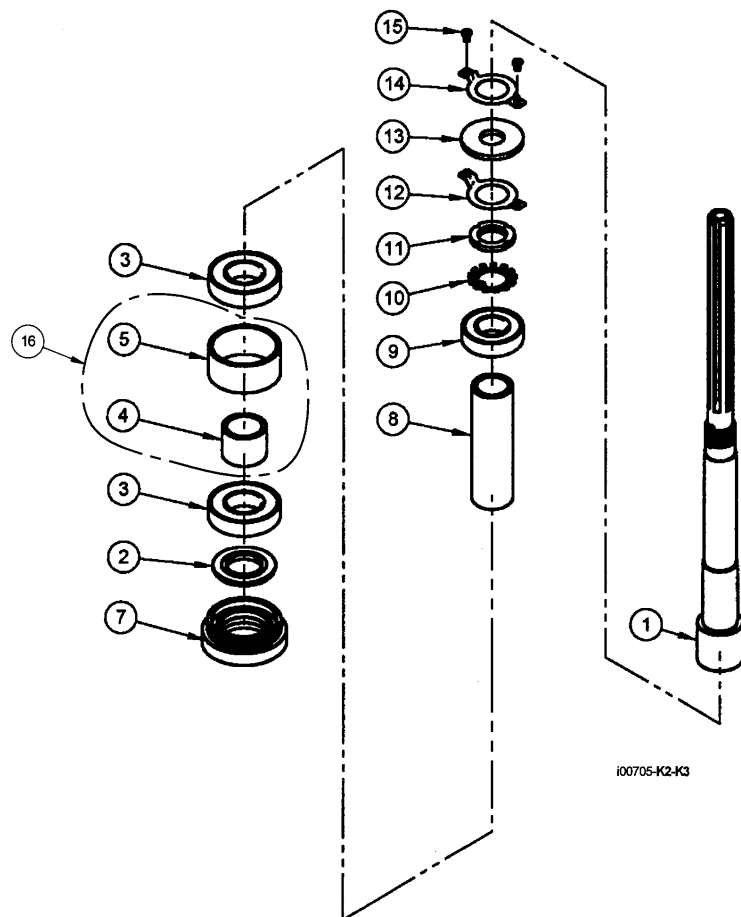
Figure 131
Overload Clutch Trip
P/N: 20779-4



Item	P/N	Title	Qty
1	K-B57	FEED WORM SHAFT	1
2	K-B47	FEED WORM SHAFT THRUST WASHER	1
3	K-B44	FEED WORM SHAFT BUSHING	1
4	K-B43	WORM	1
5	K-B59	PIN Ø 3x12L	1
6	K-B49	FEED REVERSE BEVEL GEAR	1
7	K-B48	BUSHING	1
8	K-B62	KEY 3x3x15L	1
9	K-B50	FEED REVERSE CLUTCH	1
10	K-B56	PIN Ø 3x19L	1
11	K-B51	FEED REVERSE BEVEL GEAR	1
12	K-B52	BUSHING	1
13	K-B55	REVERSE CLUTCH ROD	1

i00704-K2-K3

Figure 132
Feed Reverse Clutch
P/N: 20779-5



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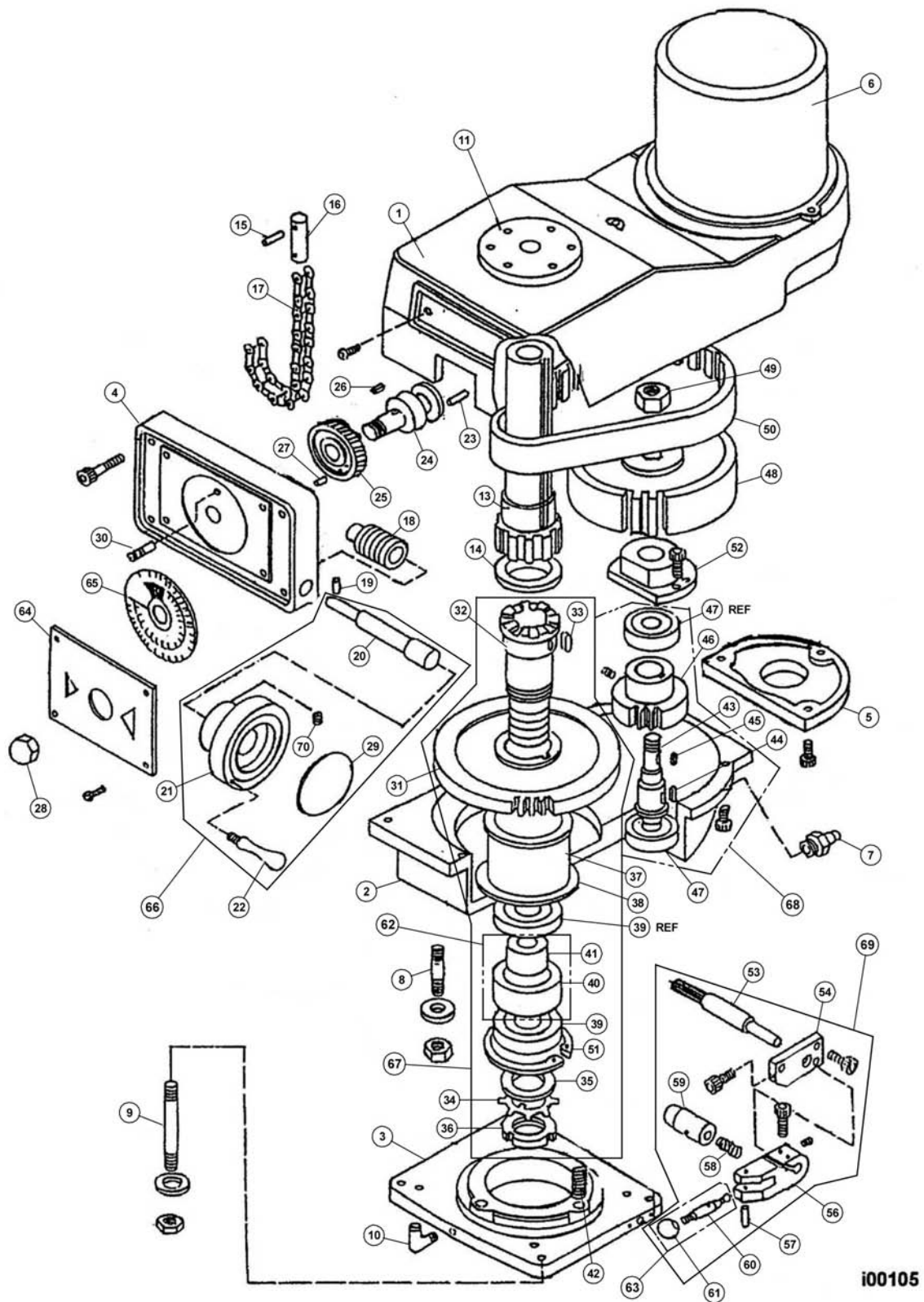
Item	P/N	DESCRIPTION	Qty
1	K-B127	SPINDLE R8	1
2	K-B134	SPINDLE DIRT SHIELD	1
3	20838	BEARING-ANGULAR CONTACT-U/SET(2)-7207 P4	1 SET
4	K-B136	BEARING SPACER-SMALL	1
5	K-B137	BEARING SPACER-LARGE	1
7	K-B133	NOSE-PIECE	1
8	K-B132	SLEEVE	1
9	K-B131	BEARING-DEEP GROVE-6206ZZ	1
10	K-B130	BEARING LOCKWASHER Ø 30	1
11	K-B129	SPINDLE BEARING LOCK NUT- Ø30-20N	1
12	K-B150-1	STRAIGHT LOWER CLAMP	1
13	K-B151	FELT OIL STRAINER	1
14	K-B150-2	STRAINER UPPER CLAMP	1
15	K-B139	SCREW-PH-HD-M5-0.8X8L	2
16	20840	BEARING SPACER SET	1

i00705-K2-K3

Figure 133
Spindle Assembly
P/N: 20836

TRM, DPM, Sport B3, & DPMS3

Figure 134 - Head Top Housing



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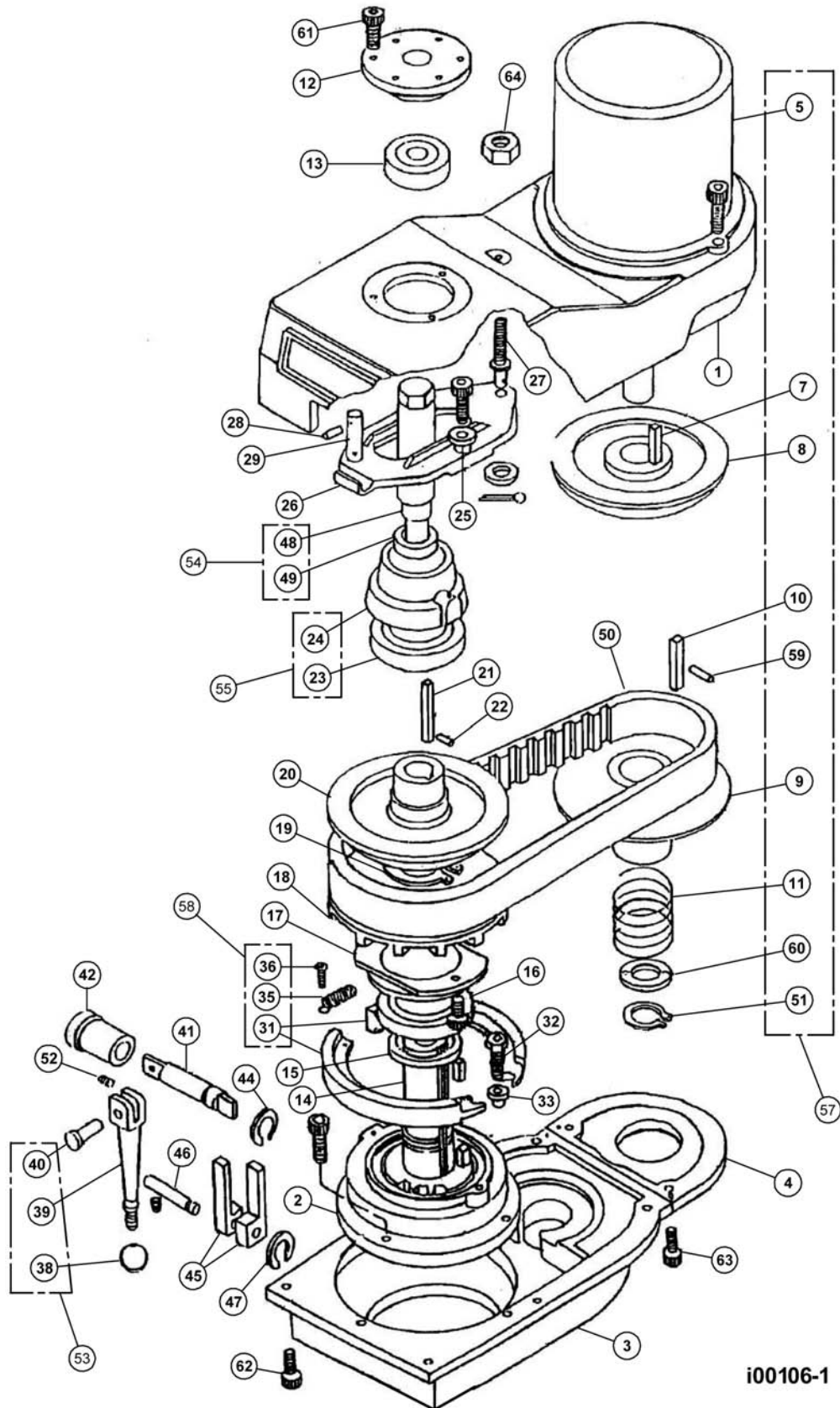
Parts List, Head Top Housing – P/N 20752R

Item	P/N	DESCRIPTION	Qty	ASSY #
1	AK001H	BELT HOUSING ASSY (SPECIAL ORDER)	1	
2	AK003H	GEAR HOUSING (SPECIAL ORDER)	1	
3	AK004H	FIXED CLUTCH BRACKET	1	
4	AK005H	SPEED CHANGER HOUSING	1	
5	AK006K	MOTOR PULLEY COVER (SPECIAL ORDER)	1	
6	16501	MOTOR VARI-DISC ASSY (AK007)	1	
7	AK014-1	GREASE CAP	1	
8	AK016	STUDS 7/16 THREAD-SHORT	3	
9	AK019	STUDS 7/16 THREAD-LONG	3	
10	AK022	OIL CUP	1	
11	AK042L	TOP BEARING CAP	1	
13	AK045L	SPINDLE PULLEY HUB	1	
14	AK046	CLUTCH SLEEVE	1	
15	AK067	ROLL PIN	1	
16	AK068K	SPEED CHANGE CHAIN STUD	1	
17	AK069	SPEED CHANGER CHAIN	1	
18	AK071	BOSTON WORM GEAR	1	
19	AK072	ROLL PIN	1	
20	AK073H	SPEED CHANGE SHAFT	1	16517
21	AK076	SPEED CHANGE HANDWHEEL	1	16517
22	AK080	HANDLE	1	16517
23	AK082	PIN	1	
24	AK083	SPEED CHANGER CHAIN DRUM	1	
25	AK084	SPEED CHANGER SPUR GEAR	1	
26	AK085	KEY 3X3X8	1	
27	AK086	PIN	1	
28	AK087	HEX CAP NUT	1	
29	AK088	PLATE-CAUTION	1	16517
30	AK092	SET SCREW	1	
31	AK100L	SPINDLE BULL GEAR ASSY	1	16514
32	AK101L	SPINDLE GEAR HUB	1	16514
33	AK102	KEY 8X8X12	1	16514
34	AK103L	LOCK WASHER	1	16514
35	AK103L-1	COLLAR	1	16514
36	AK104L	NUT	1	16514
37	AK105L	BEARING SLEEVE	1	16514
38	AK106L	BEARING GEAR SLEEVE WASHER	1	16514
39	23943	BEARING-DEEP GROVE U/SET (2)- 6910ZZ (AK109L)	1	16514
40	AK110L	BULL GEAR BEARING SPACER	1	16514/16529
41	AK111L	SLEEVE	1	16514/16529
42	AK113	COMPRESSION SPRING	3	16514
43	AK114	BULL GEAR PINION COUNTER SHAFT	1	16515
44	AK115	KEY 5X5X18	1	16515
45	AK116	KEY 5X5X11.5	1	16515
46	AK117	BULL GEAR PINION	1	16515
47	23954	BEARING-DEEP GROOVE-SET (2)-6203ZZ (AK118)	1	16515
48	AK119	PULLEY- TIMING	1	
49	AK120	JAM NUT	1	

50	AK121	BELT	1	
51	AK121L	SNAP RING	1	16514
52	AK122	BULL GEAR PINION BEARING CAP	1	
53	AK136	BULL GEAR SHIFT PINION	1	16516
54	AK137	HI-LOW DETENT PLATE	1	16516
56	AK141	HI-LOW PINION BLOCK	1	16516
57	AK142	ROLL PIN	2	16516
58	AK143	SPRING	1	16516
59	AK144	HI-LOW DETENT PLUNGER	1	16516
60	AK145	HI-LOW SHIFT CRANK	1	16516/23912
61	AK146	BAKELITE BALL HANDLE	1	16516/23912
62	16529	SPACER-BULL GEAR BEARING SPACER & SLEEVE	1	
63	23912	HI/LOW SHAFT ASSEMBLY	1	
64	AK162K-1	NAMEPLATE	1	
65	AK157L	VARI-SPEED DIAL	1	
66	16517	DPM-SPINDLE SPEED HANDWHEEL ASSY	1	
67	16514	DPM-LOW RANGE BULL GEAR ASSY	1	
68	16515	DPM-LOW RANGE PINION ASSY	1	
69	16516	DPM-LOW RANGE PINION ASSY	1	
70	AK075	SCREW-SET	1	16517
71	20752	UPPER HEAD ASSY	1	

i00105

Figure 135 - Head Back Gear TRM, DPM, Sport B3 & DPMS3



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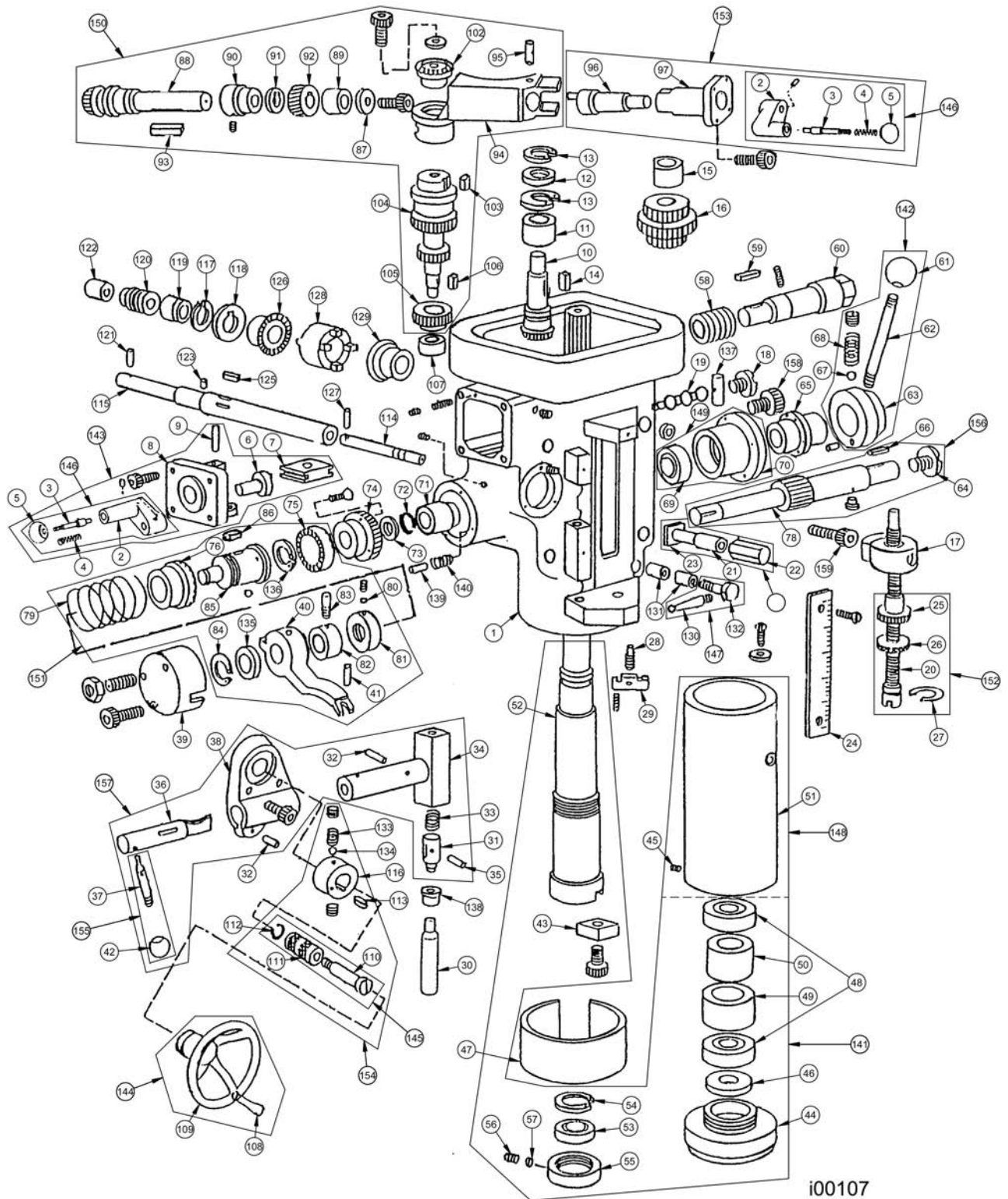
Parts List – Head Back Gear

Item	P/N	DESCRIPTION	Qty	Assy #
1	AK001H	BELT HOUSING ASSY (SPECIAL ORDER)	1	
2	AK002K	BELT HOUSING BASE	1	
3	AK003H	GEAR HOUSING (SPECIAL ORDER)	1	
4	AK006K	MOTOR PULLEY COVER	1	
5	AK007	MOTOR 3 HP- 4P 3PH (not sold separately)	1	16501
7	AK030	KEY FOR STATIONARY VARIDISC MOTOR SHAFT	1	16501
8	AK032	STATIONARY VARIDISC (NEW) (KEY NOT INCLUDED)	1	16501
9	AK036	ADJUSTABLE VARIDISC ASSY-WITH KEY (AK037)	1	16501
10	AK037	KEY 8x7x55	0	16501
11	AK039	SPRING	1	16501
12	AK042L	TOP BEARING CAP	1	
13	25719	BEARING-DEEP GROVE-6009ZZ	1	
14	AK045L	SPINDLE PULLEY HUB	1	
15	AK047	SPINDLE PULLEY SPACER	1	
16	AK048 OR 24640	BEARING-DEEP GROOVE-6912ZZ	1	
17	AK049L	BRAKE BEARING CAP	1	
18	AK051L	STATIONARY DRIVEN VARIDISC	1	
19	AK053L	SNAP RING	1	
20	AK054L	ADJUSTABLE-DRIVE VARIDISC (includes AK055 & AK056)	1	
21	AK055	KEY - 8 x 7 x 20 (INCLUDED IN AK054L)	1	AK054L
22	AK056	PIN (INCLUDED IN AK054L)	1	AK054L
23	FVS43 OR 2464	BEARING-DEEP GROVE-6013ZZ	1	16522-2
24	AK059L	SPINDLE PULLEY BEARING SLIDING HOUSING	1	16522-2
25	AK061	PIVOT SLEEVE	2	
26	AK062	SPEED CHANGE PLATE	1	
27	AK063	SPEED CHANGE PLATE PIVOT STUD	1	
28	AK067	ROLL PIN	1	
29	AK068K	SPEED CHANGE CHAIN STUD	1	
31	AK095	BRAKE SHOE ASSY (NOT SOLD SEPARATELY)	1	25059
32	AK096	HEX HD SCREW	1	
33	AK097	PIVOT SLEEVE	1	25059
35	AK099	BRAKE SPRING	2	25059
36	AK099A	GUIDE PIN FOR SPRING	4	25059
38	AK124	BAKELITE BALL HANDLE	1	16520
39	AK125	BRAKE LOCK HANDLE	1	16520
40	AK126	BRAKE LOCK PIN	1	16520
41	AK128H	BRAKE LOCK SHAFT	1	
42	AK129H	SLEEVE FOR BRAKE LOCK SHAFT	1	
44	AK131	SNAP RING	1	
45	AK132	BRAKE OPERATING FINGER	2	
46	AK133	BRAKE FINGER PIVOT STUD	1	
47	AK134	SNAP RING	1	
48	AK147L	DRAWBAR	1	16528
49	AK149L	SLEEVE	1	16528
50	AK158	BELT	1	
51	AK041K	SNAP RING	1	16501
52	AK127	SCREW-SET (M5x.8)	1	

53	16520	BRAKE HANDLE ASSY.	1	
54	16528	DRAWBAR & SLEEVE (MANUAL)	1	
55	16522-2	HOUSING-BEARING HOUSING ASSY(NEW) 6013	1	
57	16501	MOTOR/VARIDISC ASSY	1	
58	25059	BRAKE SHOE ASS'Y (NOT SOLD SEPARATELY)	1	
59	AK037-1	ROLL PIN	1	16501
60	AK040K	ADJUSTABLE VARIDISC SPRING COLLAR	1	16501
61	M6X1.0X20 25B	SCREW-SHCS-STL-BO	6	
62	M8X1.25X20 25B	SCREW-SHCS-STL-BO	6	
63	M5X0.8X15 25B	SCREW-SHCS-STL-BO	3	
64	3/8-16 50B	NUT-HEX-STL-BO	1	

i00106-1

Figure 136 - Head Lower Housing TRM, DPM, Sport B3, DPMS3



Parts List – Head Lower Housing

Item	P/N	DESCRIPTION	Qty	ASSY #
1	A012H	QUILL HOUSING (SPECIAL ORDER ONLY)	1	
2	A042H	SHIFT CRANK	2	16507/16526
3	A042H-1	PLUNGER	2	16507/16526
4	A042H-4	COMPRESSION SPRING	2	16507/16526
5	A042H-5	BALL	2	16507/16526
6	A045	CLUSTER GEAR SHIFT CRANK	1	16507
7	A047	FEED GEAR SHIFT FORK	1	16507
8	A048	CLUSTER GEAR COVER	1	16507
9	A049	FEED SHIFT ROD	1	16507
10	A053	CLUSTER GEAR SHAFT	1	
11	A054	BEVEL GEAR BEARING	1	
12	A055	BEVEL GEAR THRUST SPACER	1	
13	A056	SNAP RING	2	
14	A060	CLUSTER GEAR KEY	1	
15	A062	CLUSTER GEAR SHAFT UPPER BEARING	1	
16	A063	CLUSTER GEARS ASSY	1	
17	A065	QUILL STOP KNOB	1	
18	A066	REVERSE TRIP BALL LEVER SCREW	1	
19	A067	REVERSE TRIP BALL LEVER	1	
20	A068	QUILL STOP MICRO-SCREW	1	16513
23	A071	T-BOLT ASSY	4	
24	A073	MICROMETER SCALE	1	
25	A074	MICROMETER NUT	1	16513
26	A075	QUILL MICRO-STOP NUT	1	16513
27	A076	SNAP RING	1	16513
28	A078	TRIP LEVER PIN	1	
29	A079	FEED TRIP LEVER	1	
30	A080	FEED TRIP PLUNGER	1	
31	A082	TRIP PLUNGER	1	16508
32	A083	ROLL PIN	2	16508
33	A084	COMPRESSION SPRING	1	16508
34	A085	CAM ROD SLEEVE ASSY	1	16508
35	A086	ROLL PIN	1	16508
36	A087L	CAM ROD	1	16508
37	A089	TRIP HANDLE	1	23913/16508
38	A092	FEED TRIP BRACKET	1	16508
39	A094	CLUTCH ARM COVER	1	
40	A096H	OVERLOAD CLUTCH TRIP LEVER	1	
41	A098	PIN	1	16508
42	A098-1	BLACK PLASTIC BALL	1	23913/16508
43	A101H-1	DRIVE KEY	2	16502
44	A102H	NOSE PIECE #40	1	16502
45	A102L-3	SET SCREW	1	16502
46	A103L	SPINDLE DIRT SHIELD	1	16502
47	A104L	QUILL SKIRT	1	
48	20839 (A105L)	BEARING-ANG CT U/SET (2)-7010-P4	1	16502
49	A106L	BEARING SPACER-LARGE	1	16502

50	A107L	BEARING SPACER-SMALL	1	16502
51	A109H	QUILL	1	16502
52	A110H	SPINDLE #40 (NOT FOR SALE)	1	16502
53	26392 (A112H)	BEARING-DEEP GROVE-6008ZZ	1	16502
54	A113H	SNAP RING	1	16502
55	A114H	LOCKNUT	1	16502
56	A114H-1	SPECIAL SOCKET SET SCREW	1	16502
57	A114H-2	WASHER	1	16502
58	A154	WORM GEAR	1	
59	A155	TRM-KEY	1	
60	A156H	TRM-WORM SHAFT	1	
61	A164	BLACK PLASTIC BALL HANDLE	1	16506
62	A165	PINION SHAFT HUB HANDLE	1	16506
63	A166	BACK FEED HANDLE HUB	1	16506
64	A167	PINION SHAFT HUB SCREW	1	16505
65	A168	PINION SHAFT HUB SLEEVE	1	
66	A169	KEY	1	
67	A170	BALL	1	16506
68	A170A	COMPRESSION SPRING	1	16506
69	A173	CLOCK SPRING	1	16504
70	A174	SPRING COVER	1	16504
71	A176	QUILL PINION SHAFT BUSHING	2	16505
72	A176-1	SNAP RING	1	
73	A177	PINION SHAFT WORM GEAR SPACER	1	
74	A178	OVERLOAD CLUTCH WORM GEAR	1	
75	A180	OVERLOAD CLUTCH RING	1	16512
76	A181	OVERLOAD CLUTCH	1	16512
78	A182L	QUILL PINION SHAFT	1	16505
79	A183	SAFETY CLUTCH SPRING	1	16512
80	A185	PLUG-BRASS	1	16512
81	A186	OVERLOAD CLUTCH LOCKNUT	1	16512
82	A187	CLUTCH RING	1	16512
83	A188	CLUTCH RING PIN	1	16512
84	A189	SNAP RING	1	16512
85	A190	OVERLOAD CLUTCH SLEEVE	1	16512
86	A190A	KEY	1	16512
87	A192L	WASHER	1	16511
88	A193L	FEED DRIVE WORM GEAR SHAFT	1	16511
89	A196L	FEED WORM GEAR SHAFT SLEEVE	1	16511
90	A197L	WORM CRADLE BUSHING	1	16511
91	A198L	WORM GEAR SPACER	1	16511
92	A199L	FEED DRIVE WORM GEAR	1	16511
93	A200	WORM SHAFT KEY	1	16511
94	A202L	WORM GEAR CRADLE	1	16511
95	A203	FEED ENGAGE PIN	1	16511
96	A206H	WORM GEAR CRADLE THROW-OUT	1	16519
97	A208H	SHIFT SLEEVE	1	16519
102	A217	FEED REVERSE BEVEL GEAR	1	16511
103	A217H	CLUSTER GEAR KEY	1	16511
104	A218H	FEED DRIVING GEAR	1	16511

105	A221H	FEED DRIVE GEAR	1	16511
106	A222H	KEY	1	16511
107	A223	BEARING-NEEDLE	1	
108	A224	HANDLE	1	16509
109	A225	HANDWHEEL	1	16509
110	A226	FEED REVERSE KNOB STUD	1	16525
111	A227	REVERSE KNOB	1	16525
112	A228	SNAP RING	1	16525
113	A230	KEY	1	
114	A231H	REVERSE CLUTCH ROD	1	
115	A232H	FEED WORM SHAFT	1	
116	A233	HANDWHEEL CLUTCH	1	
117	A235-1	FEED WORM SHAFT THRUST WASHER	1	
118	A235L	BUSHING	1	
119	A236	FEED WORM SHAFT BUSHING	1	
120	A237	WORM	1	
121	A238	PIN	1	
122	A239	BUSHING	1	
123	A240	PIN	1	
125	A242	KEY	1	
126	A241	FEED REVERSE BEVEL GEAR	2	
127	A243	ROLL PIN	1	
128	A244	FEED REVERSE CLUTCH	1	
129	A245	FEED REVERSE BEVEL GEAR	1	
130	A246H	LOCK HANDLE	1	16527
131	A247H	QUILL LOCK SLEEVE	1	
132	A248H	QUICK LOCK BOLT	1	16527
133	A267	COMPRESSION SPRING	1	
134	A269	STEEL BALL	1	
135	A270	OVERLOAD CLUTCH WASHER	1	16512
136	A273	SNAP RING	1	16512
137	A274	FEED REVERSE TRIP PLUNGER	1	
138	A276	TRIP PLUNGER BUSHING	1	
139	A277	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1	
140	A278	COMPRESSION SPRING	1	
141	16502	DPM-SPINDLE ASSY	1	
142	16506	DPM-QUILL HANDLE ASSY	1	
143	16507	DPM-FEEDRATE SELECTOR ASSY	1	
144	16509	DPM-FEED HANDWHEEL ASSY	1	
145	16525	DPM-TRM ASSY-FEED REVERSE KNOB	1	
146	16526	DPM-TRM ASSY-SHIFT CRANK	2	
147	16527	DPM-LOCK HANDLE AND BOLT	1	
148	16503	SPINDLE/QUILL ASSY	1	
149	16504	CLOCK SPRING ASSY	1	
150	16511	FEED CRADLE ASSY	1	
151	16512	FEED CLUTCH ASSY	1	
152	16513	MICRO SCREW ASSY	1	
153	16519	HANDLE-FEED ENGAGE HANDLE ASSY	1	
154	16521	FEED REVERSE KNOB ASSY	1	
155	23913	TRIP HANDLE ASSEMBLY	1	
156	16505	FRU-DPM-QUILL PINION ASSY	1	

157	16508	FRU-DPM-FEED TRIP ASSY	1	
158	M5-.8X15	SCREW	1	
159	3/8-24X1 1/4	SCREW	1	

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Lubrication Drawings - TRM - Lubrication System

QTY.	PART NO.	DESCRIPTION
2	L001	Lubrication Pump
1	L002	Ram Manifold
—	L003	Lub Machine Coupling Set
14	L004	Lub Minifold Coupling Set
—	L005	Lub Tubing (2 feet)
1	L006	Saddle Manifold
1	L007	Flexible Lub Hose

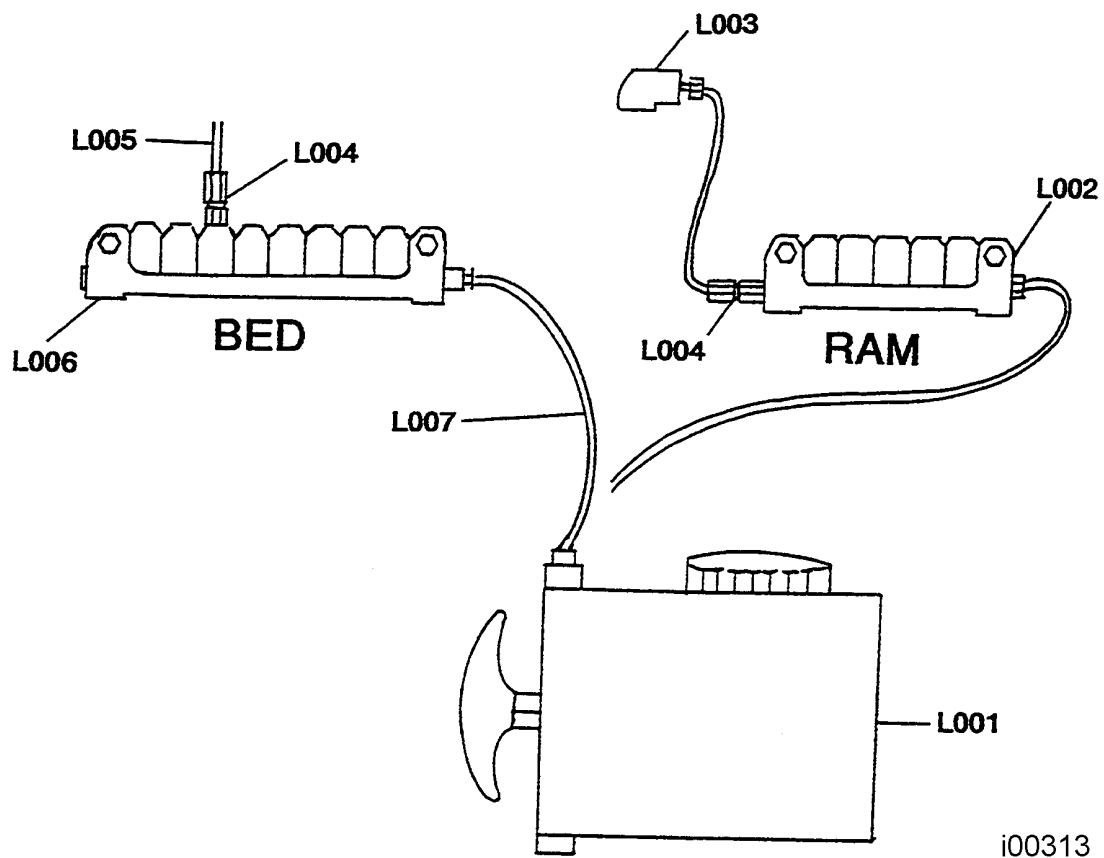


Figure 137 Lubrication System TRM

DPM, Sport B3 & Sport B5 – Lubrication System

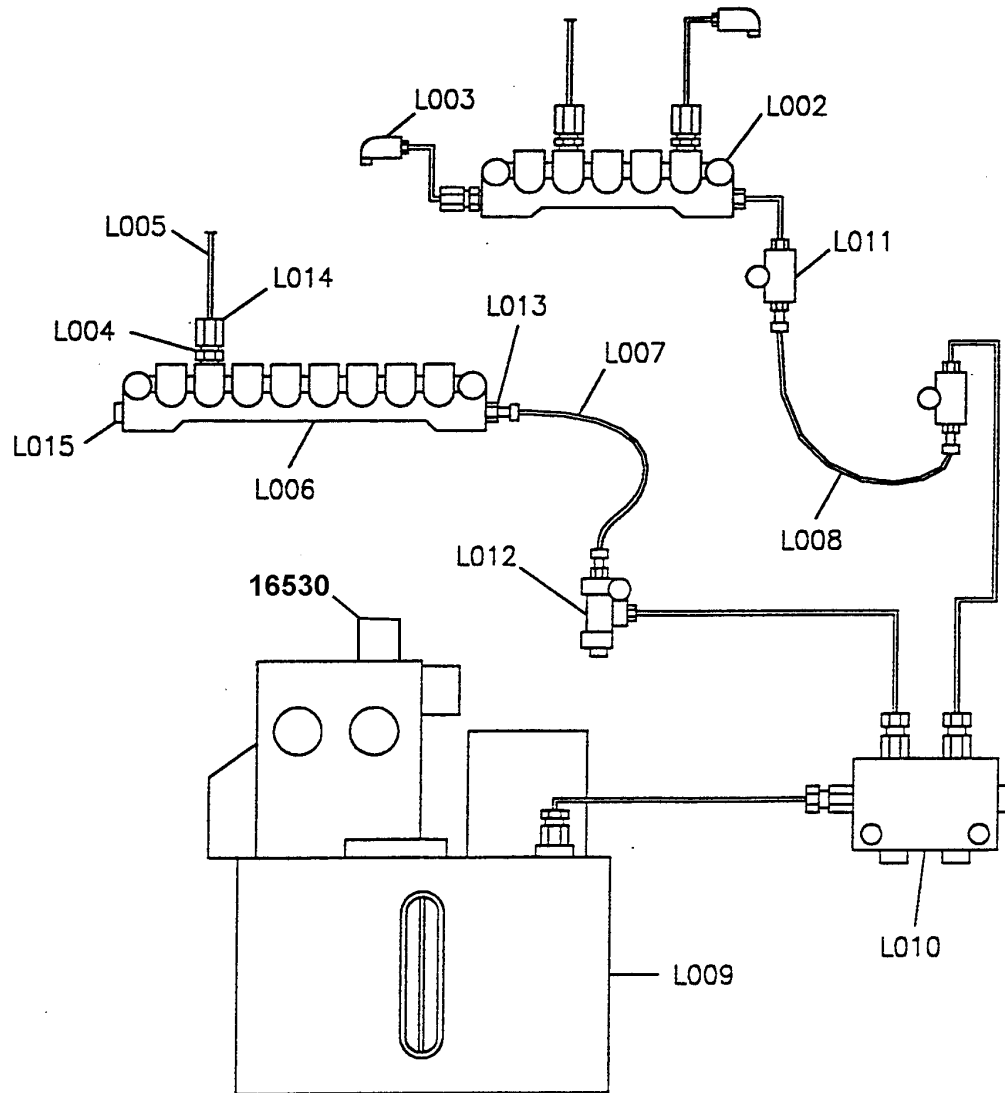
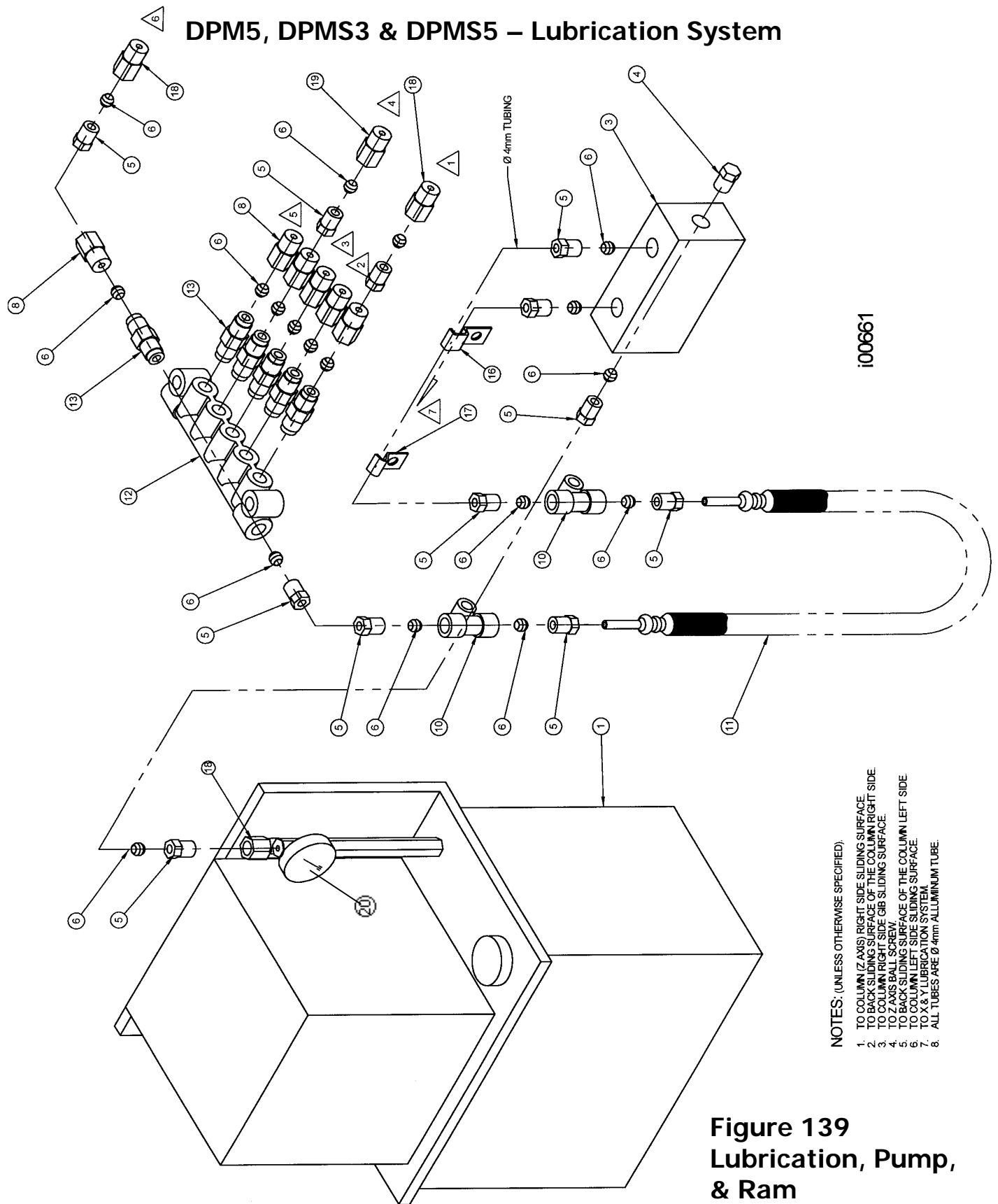


Figure 138 **Lubrication System**
DPM, Sport B3 & Sport B5

Lubrication System Parts List – DPM, Sport B3 & Sport B5

QTY.	PART NO.	DESCRIPTION
1	L002	RAM MANIFOLD (A-7)
2	L003	LUB MACHINE COUPLING SET (PH-401, PA-4, PB-4)
14	L004	LUB MANIFOLD COUPLING (SS-2)
-	L005	LUB TUBING
1	L006	SADDLE MANIFOLD (A-10)
1	L007	FLEXIBLE LUB HOSE, RAM ($\phi 4$ X 300 LG)
1	L008	FLEXIBLE LUB HOSE, SADDLE ($\phi 6$ X 700 LG) (4 X 700 LG)
1	L009	OIL FEEDING SYSTEM (CEA-2 ϕ X 110V)
1	L010	OIL REGULATING DISTRIBUTOR (B-2 $\phi 4$)
2	L011	TWIN JOINT SET (JD-4, PA-4, PB-4)
1	L012	T-JOINT SET (PKD-4, PA-4, PB-4)
2	L013	THIMBLE SET (PA-4, PB-4)
14	L014	SCREW NUT (R-08, PB-4)
2	L015	PLUG (PG-004)
1	16530	OILER COVER

DPM5, DPMS3 & DPMS5 – Lubrication System



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NOTES: (UNLESS OTHERWISE SPECIFIED).

1. TO COLUMN (Z AXIS) RIGHT SIDE SLIDING SURFACE.
2. TO BACK SLIDING SURFACE OF THE COLUMN RIGHT SIDE.
3. TO COLUMN RIGHT SIDE GB SLIDING SURFACE.
4. TO Z AXIS BALL SCREW.
5. TO BACK SLIDING SURFACE OF THE COLUMN LEFT SIDE.
6. TO COLUMN LEFT SIDE SLIDING SURFACE.
7. TO X & Y LUBRICATION SYSTEM.
8. ALL TUBES ARE Ø 4mm ALUMINUM TUBE.

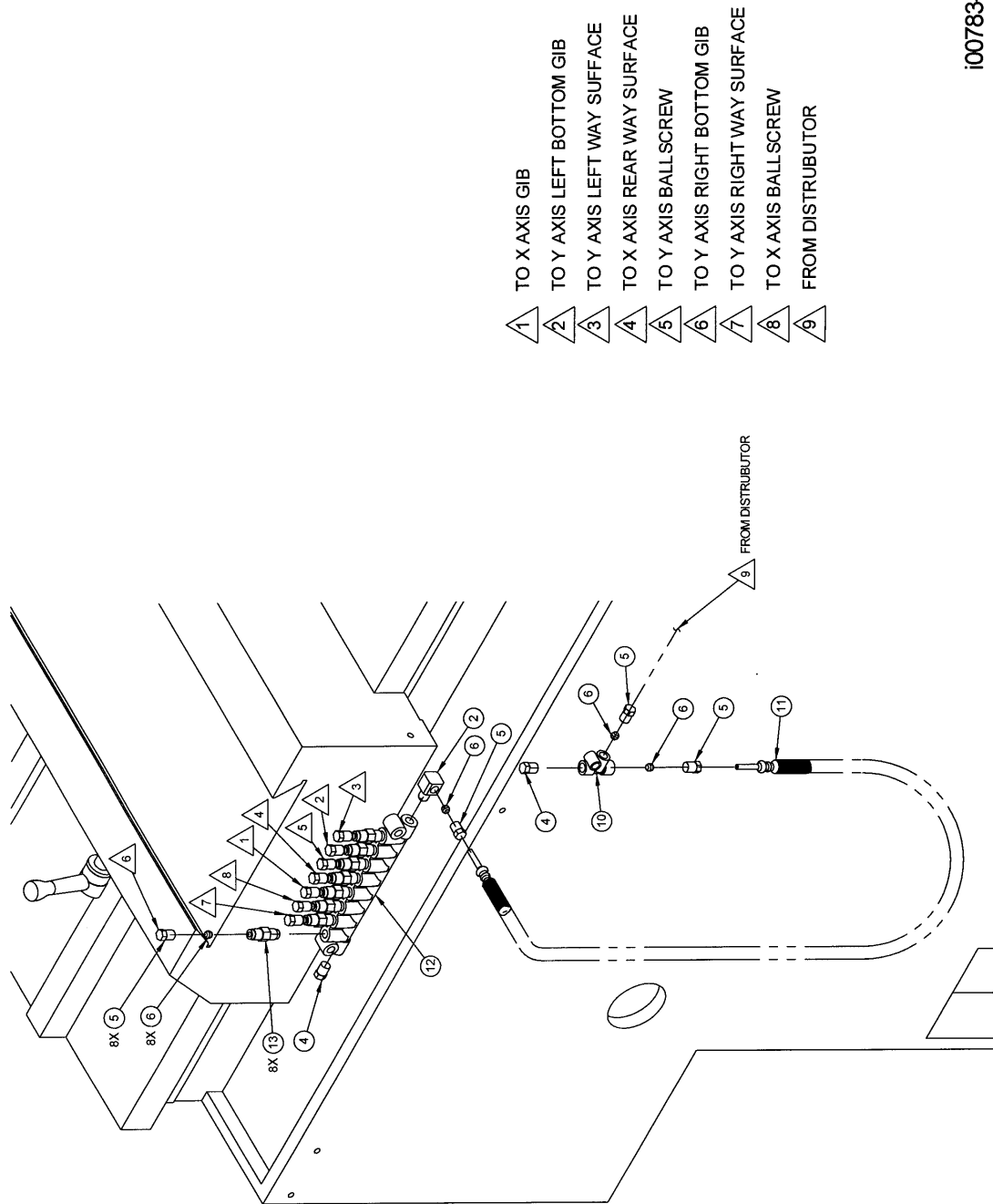
Figure 139
Lubrication, Pump,
& Ram
DPM5, DPMS3,
DPMS5

Parts List Lubrication, Pump & Ram
DPM5, DPMS3, DPMS5

Item	P/N	Description	Qty
1	21157-1	LUBRICATION PUMP-DPM5	0
3	B-3	DISTRIBUTOR-OIL REGULATING B-3	0
4	PG004	PLUG- M8 X 1.0	0
5	PA4	BUSHING	13
6	PB4	SLEEVE-4 MM	19
8	PAN4	NUT	6
10	JD-4	2-WAY JUNCTION	1
11	FHC407	TUBE- STEEL ROPE & HOSE	1
12	DB7	DISTRIBUTOR	1
13	PSS4	OIL DISTRIBUTOR	6
14	A4	TUBING-4MM ALUM	A/R
16	PZ0204	CLAMP	1
17	PZ0104	CLAMP	1
18	PD401	ADAPTER	3
19	PD408	ADAPTER	1
20	16532	OILER GAUGE DIAL	1

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Figure 140 Lubrication, X & Y Axis – DPMS3



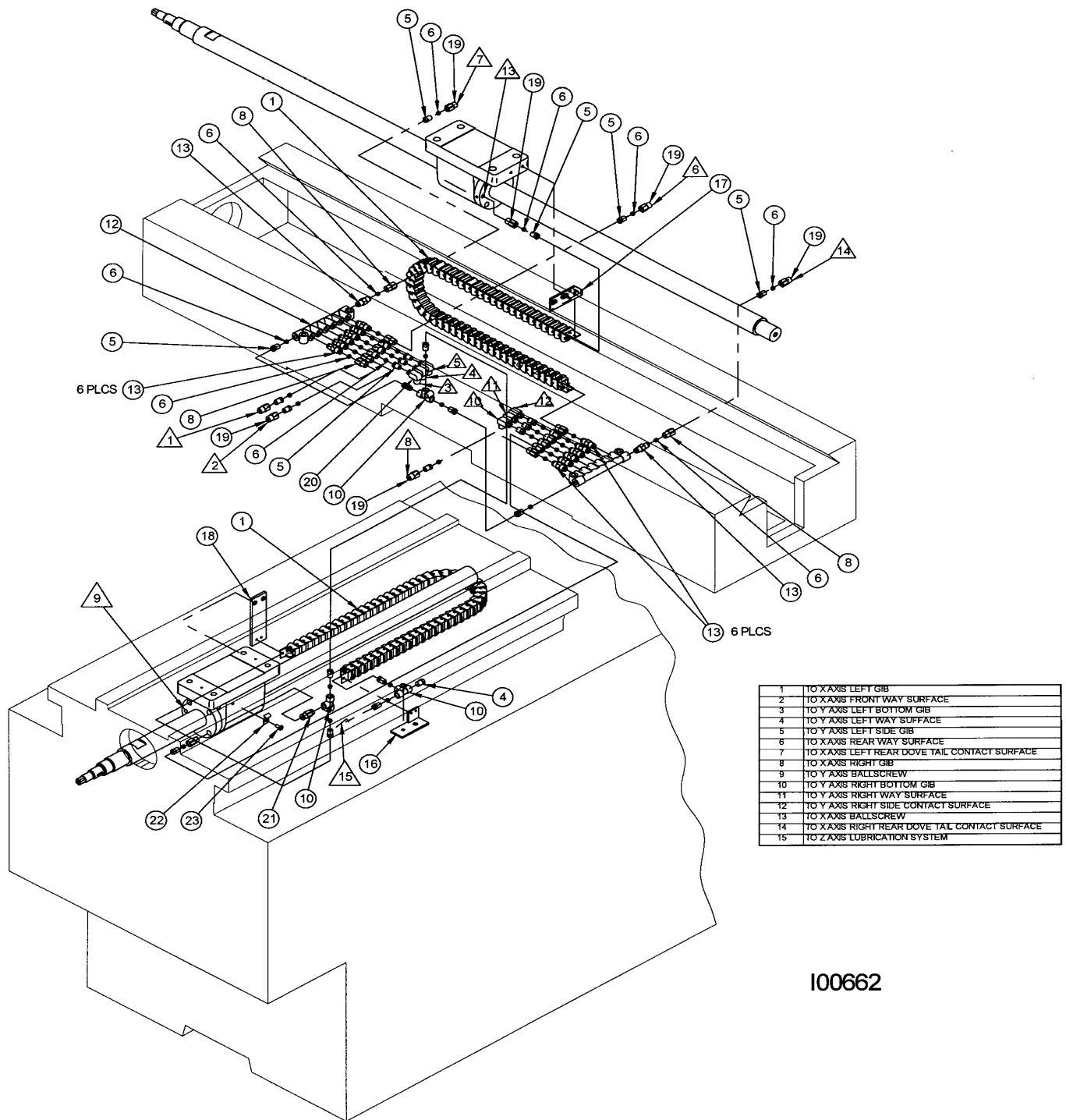
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Parts List - Lubrication – X & Y Axis – DPMS3

Item	P/N	Description	Qty
1			
2	PH4-8	ELBOW	1
3			
4	L015	PLUG- M8 X 1.0-PG004	2
5	L013	BUSHING-PA4	11
6	L014	SLEEVE-4 MM-PB4	11
7			
8			
10	L012	TEE ADAPTER-PKD4	1
11	L008	HOSE	1
12	L006	DISTRIBUTOR-DB10	1
13	PSS4	OIL DISTRIBUTOR	8
14	L005	TUBING-4MM ALUM-A4	XX
15			

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**Figure 141 Lubrication System, X & Y Axis
DPM5 & DPMS5**



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Parts List – Lubrication System, X & Y Axis – DPM5

NO.	P/N	DESCRIPTION	QTY
1		CHAIN 10MM X 10MM X 34 UNITS	2
4	PG004	PLUG-M8x1.0	1
5	PA4	BUSHING	23
6	PB4	SLEEVE, Ø4	37
8	PAN4	NUT	14
10	PKD4	3-WAY JUNCTION	3
12	DB8	DISTRIBUTOR	2
13	PSS4	OIL DISTRIBUTOR	14
14	A4	Ø 4 ALUM. TUBING	A/R
16	21738	BRACKET- X & Y AXIS LUBRICATION	1
17	21736	BRACKET- X AXIS CHAIN GUIDE	1
18	21737	BRACKET- X & Y AXIS LUBRICATION	1
19	PD408	ADAPTER-	8
20	PH408	ADAPTER- RIGHT ANGLE	6
21	PQ8T	NIPPLE- M8	1
22	PZ0104	CLAMP	1
23	M5 P0.8x10	SCREW- PAN HD PHILLIPS	1

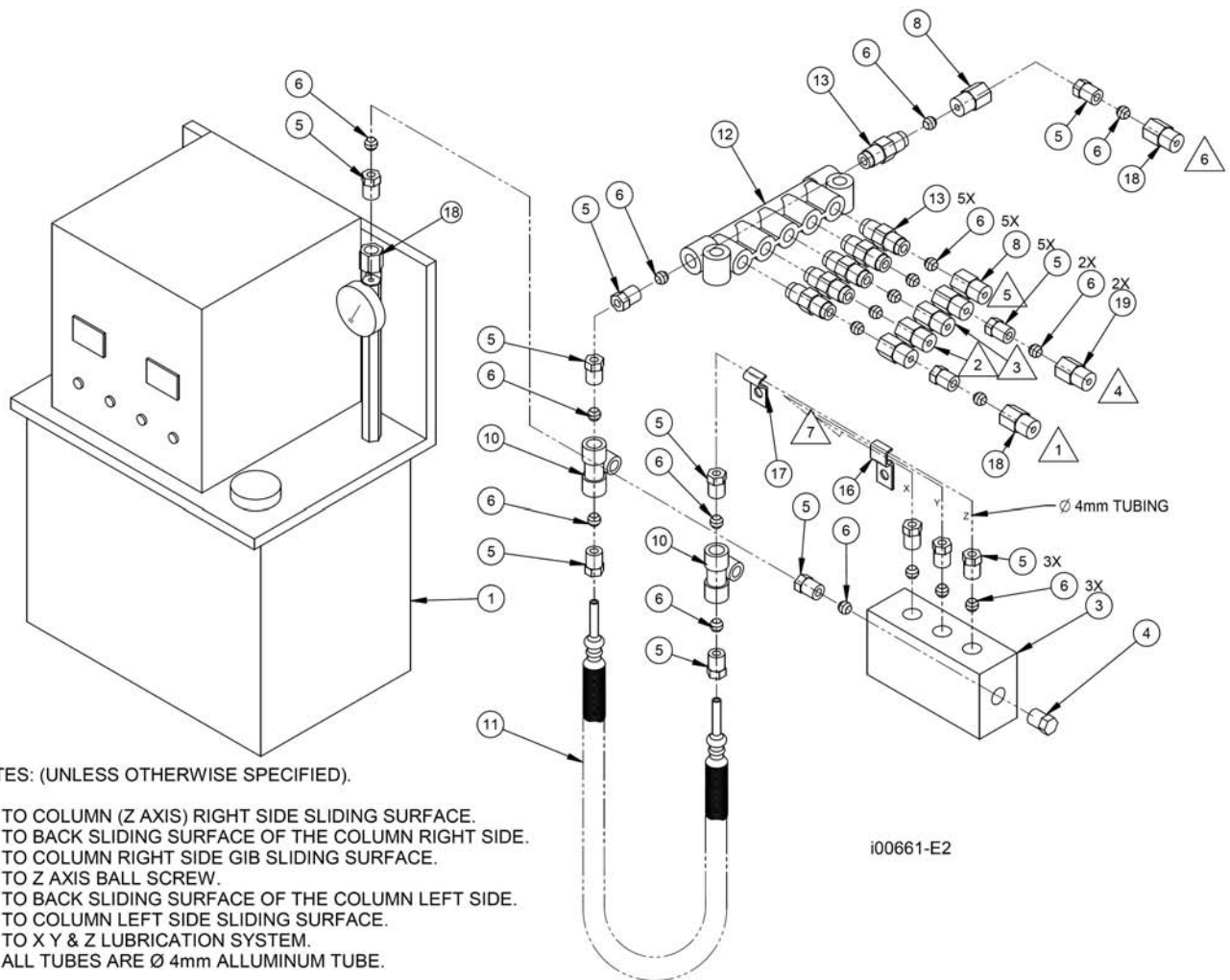
Parts List – Lubrication Drawing, X & Y Axis – DPMS5

Item	P/N	Description	Qty
1	P8011010	CHAIN 10MM X 10MM X34 UNITS	1
2	P8621010	CHAIN 10MM X 10MM X42 UNITS	1
4	PG004	PLUG- M8 X 1.0	1
5	PA4	BUSHING	21
6	PB4	SLEEVE-4 MM	35
8	PAN4	NUT	14
10	JD-4	2-WAY JUNCTION	2
12	DB8	DISTRIBUTOR	2
13	PSS4	OIL DISTRIBUTOR	14
14	A4	TUBING-4MM ALUM	144
15	P04	TUBING-4MM PLASTIC	108
16	23254	BRACKET- X & Y AXIS LUBRICATION	1
17	22346	BRACKET- LUBE X-AXIS BALL SCREW	1
18	21737	BRACKET- X & Y AXIS LUBRICATION	1
19	PD408	ADAPTER	2
20	PH408	ADAPTER- RIGHT ANGLE	13
22	PZ0104	CLAMP	1
23	M5-0.8X10 10B	SCREW-PH-PHIL-STL-BO	1
24	PH4-8	CONNECTOR-	1
25	M8-1.25X25 25B	SCREW-SHCS-STL-BO	2
26	M6-1.0X16 20B	SCREW-RH-PHIL-STL-BO	2

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DPME2 – Lubrication System

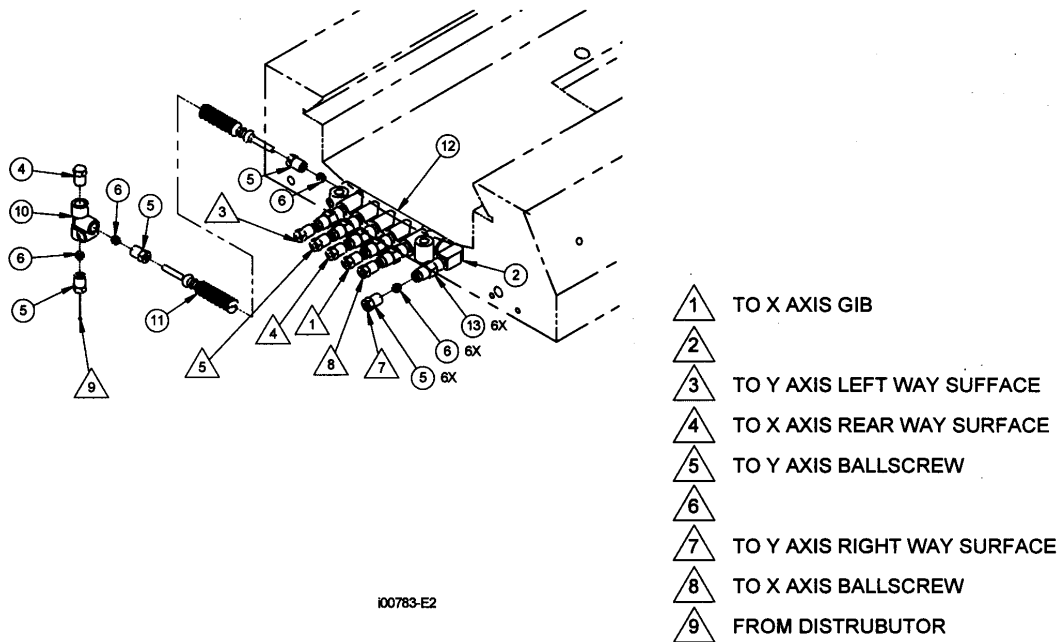
Figure 142 Pump & Lube System



Parts List – Lubrication, Pump & Lube System – DPME2

Item	P/N	Description	Qty
1	21157-1 = blue 21157-1 = green	LUBRICATION PUMP-DPME2	0
3	B-3	OIL-OIL REGULATING B-3	0
4	PG004	PLUG- M8 X 1.0	0
5	PA4	BUSHING	13
6	PB4	SLEEVE-4 MM	19
8	PAN4	NUT	6
10	JD-4	2-WAY JUNCTION	1
11	L008	TUBE- STEEL ROPE & HOSE	1
12	DB7	DISTRIBUTOR	1
13	PSS4	OIL DISTRIBUTOR	6
14	A4	TUBING-4MM ALUM	A/R
16	PZ0204	CLAMP	1
17	PZ0104	CLAMP	1
18	PD401	ADAPTER	3
19	PD408	ADAPTER	1

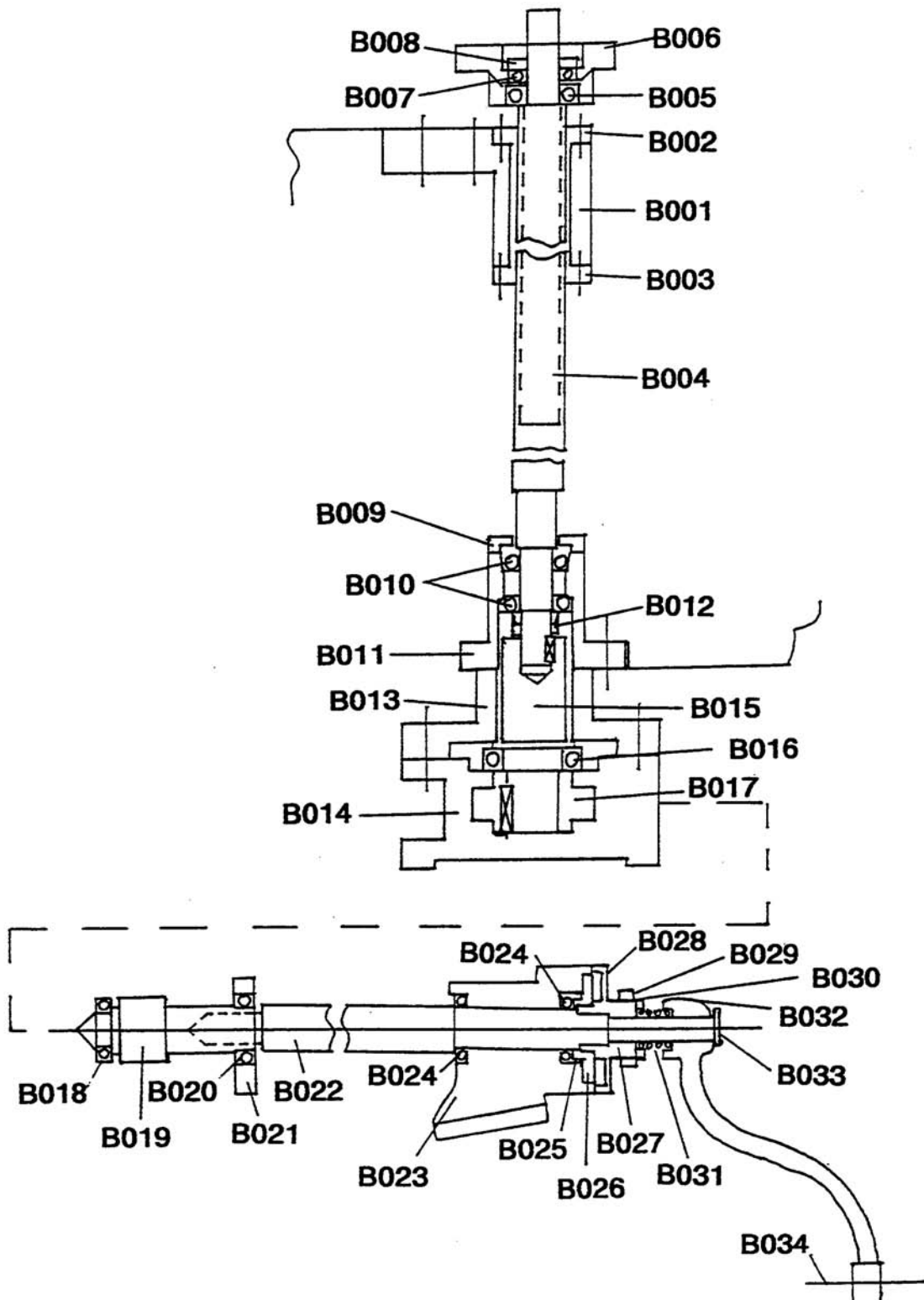
Figure 143 Lubrication Drawing, X & Y Axis – DPME2



Item	P/N	Description	Qty
1			
2	PH4-8	ELBOW	1
3			
4	L015	PLUG- M8 X 1.0-PG004	1
5	L013	BUSHING-PA4	9
6	L014	SLEEVE-4 MM-PB4	9
7			
8			
10	L012	TEE ADAPTER-PKD4	1
11	FHC405	HOSE	1
12	L006	DISTRIBUTOR-DB10	1
13	PSS4	OIL DISTRIBUTOR	6
14	L005	TUBING-4MM ALUM-A4	XX
15			

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Figure 144 Head/Ram Riser Drive System -- TRM



Parts List, Head/Ram Riser Drive System (for Figure 6-45)

QTY.	PART NO.	DESCRIPTION
1	B001	Ram Riser, Feed Nut Bracket
1	B002	Ram Riser Nut--Top
1	B003	Ram Riser Nut--Bottom
1	B004	Ram Riser Screw
1	B005	Bearing--62042
1	B006	Ram Riser Top Bracket
1	B007	Bearing--51104
1	B008	Nut--AN04
1	B009	Bearing Protector
2	B010	Bearing--30205
1	B011	Ram Riser Screw Lower Bracket
2	B012	Nut--AN05
1	B013	DC Motor Seat
1	B014	Gear Box
1	B015	Screw Gear Shaft
1	B016	Bearing--60092
1	B017	Bevel Angle Spur Gear
1	B018	Bearing--6004Z
1	B019	Bevel Angle Spur Gear
1	B020	Bearing--6006Z
1	B021	Screw Gear Bearing Cover
1	B022	Riser Transfer Shaft
1	B023	Riser Transfer Shaft Bracket
2	B024	Bearing--6006Z
1	B025	Bearing Sleeve
1	B026	Bearing Cover
1	B027	Dial Holder
1	B028	Dial
1	B029	Bushing
1	B030	Clutch
1	B031	Spring
1	B032	Ram Riser Crank
1	B033	Snap Ring
1	B034	Handle Grip

Counter Balance System Parts List

QTY.	PART NO.	DESCRIPTION
1	B100	Counter Balance (TRM)
4	B101	Chain Attachment Bolt/Nut
2	B102	Chain Gear Seat
4	B103	Chain Gear
2	B104	Chain Gear Shaft
4	B105	Snap Ring - S-20
1	B107	Counter Balance (DPM)
2	B108	Chain Gear Seat (DPM)
2	B109	Chain Gear (DPM)
2	B110	Chain Gear Shaft (DPM)
	B111	Snap Ring (DPM)

Other Column Parts Parts List

QTY.	PART NO.	DESCRIPTION
1	B200	Column Top Cover (TRM)
1	B201	Way Cover, Top Column, Accordion
1	B202	Way Cover, Bottom Column, Accordion
2	B203	Ram Gib Lock Handle and Plunger
2	B204	Ram Back Gib (TRM)
1	B205	Ram Side Gib (TRM)
6	B206	Ram Gib Adjustment Screw
set	B208	Ram Gib Chip Guards and Gaskets
1	B209	ProtoTRAK Pendant Arm Assembly
1	B242	Column Top Cover (DPM)
2	B243	Ram Back Gib (DPM))
1	B244	Ram Side Gib (DPM))
1	B245	Cable Guard (DPM)

Other Bed Parts Parts List

QTY.	PART NO.	DESCRIPTION
1	B230	Vent--Left Side
1	B231	Vent--Right Side
1	B232	Vent--Left Front (TRM)
1	B233	Vent--Right Front
2	B238	Coolant Screen
6	B239	Foot Pads
6	B240	Footpad Bolt/Nut
1	B246	Vent, Left Front (DPM)

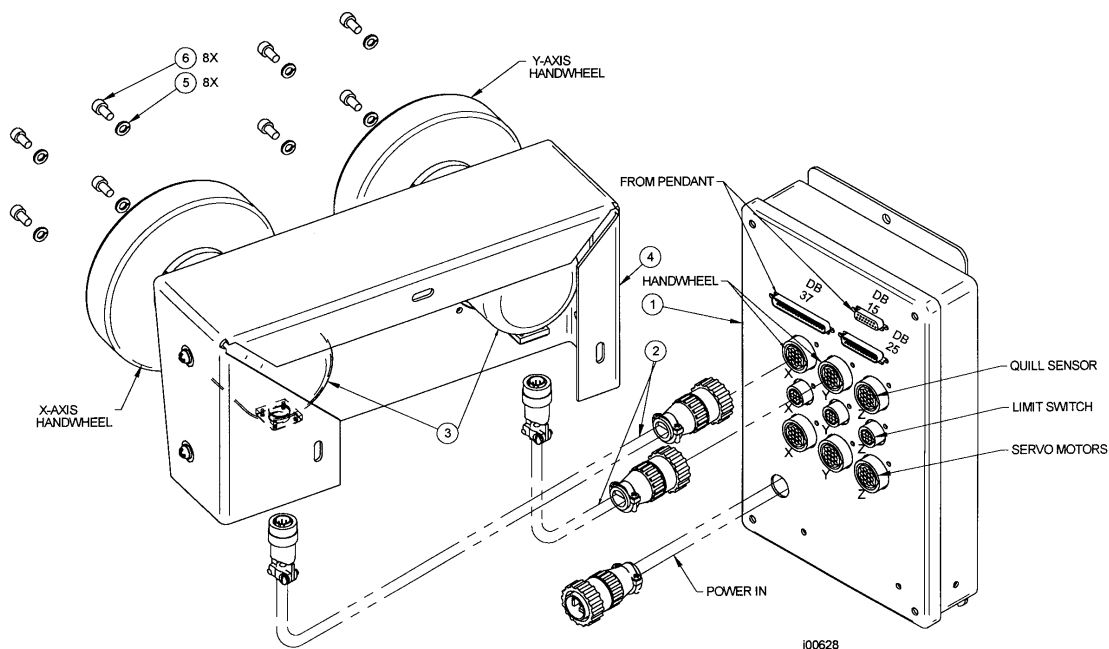
Other Table/Saddle Parts Parts List

QTY.	PART NO.	DESCRIPTION
2	B260	Table Gib Lock Handle & Plunger
1	B261	Saddle Gib Lock Handle & Plunger
1	B262	Table Gib
2	B263	Saddle Bottom Gib
1	B264	Saddle Side Gib
2	B265	Table Gib Adjustment Screw
6	B266	Saddle Gib Adjustment Screw
1	B267 (DPM)	Way Cover, Back, Bed DPM5 B267-1
1	B268 (DPM)	Way Cover, Front, Bed DPM5 B268-1
1	B269	Table Stop Dog
2	B270	Table Adjustable Stops
set	B271	Saddle Gib Chip Guards & Gaskets
1	B273 (15955)	Y TRAK Sensor Bracket & Guard 16482 (guard)
1	B274 (16479)	X TRAK Sensor Bracket & Guard 16481 (guard)
1	B277	Table Tray
1	B278	Table Tray Rubber Pad
Set	B279	Chip Guard Plates Covering Y Ball Screw

TRAK A.G.E. Control System Parts List

QTY.	PART NO.	DESCRIPTION
1	20296	Motor/Driver Assembly - Y Axis
1	20276	Motor/Driver Assembly - X Axis
1	20328	Motor/Driver Assembly - Z Axis (DPM)
1	20252-1	Control Cabinet Assembly (TRM)
1	20253-2	Control Cabinet Assembly (DPM)
1	20180	Pendant Assembly (TRM)
1	20180-1	Pendant Assembly (DPM)
3	M250C	Sensor M250C
1	16961	Switch Box Assembly (DPM)
1	20065-220	Relay Module, 220V (TRM)
1	20065-440	Relay Module, 440V (TRM)
1	17009-220	Relay Module, 220V (DPM)
1	17009-440	Relay Module, 440V (DPM)

Figure 145, Electronic Hand Wheel Assembly and Parts List



NO.	P/N	DESCRIPTION	QTY
1	20290-1	EXTERNAL CABLE BOX	1
2	21735	CABLE ASSY- ELECTRONIC HANDWHEEL	2
3	20082-1	X & Y AXIS HANDWHEEL	2
4	21583	HANDWHEEL BOX- SHEET METAL	REF
5	M6 73B	WASHER - LOCK BLK OX	8
6	M6-1.0x12	SCREW- SOC HD CAP, BLK OX	8

Southwestern Industries, Inc

TRAK Warranty Policy

Warranty

TRAK products are warranted to the original purchaser to be free from defects in work-manship and materials for the following periods:

Product	Warranty Period	
	Materials	Factory Labor
New TRAK	1 Year	1 Year
Any EXCHANGE Unit	90 Days	90 Days

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, Inc. (SWI) or their authorized distributor.

If a unit under warranty fails, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB Factory/Los Angeles or the location of our nearest factory representative or authorized distributor.

Disclaimers of Warranties

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of SWI (or any producing entity, if different).
- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.
- SWI is not responsible for consequential damages from use or misuse of any of its products.
- TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require.
- Replacement of chip scrapers and wipers is the responsibility of the customer. Consequently, the warranty does not apply if chips have been allowed to enter the mechanism.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if an instrument has been abused, dropped, hit, disassembled or opened.
- Improper installation by or at the direction of the customer in such a way that the product consequently fails, is considered to be beyond the control of the manufacturer and outside the scope of the warranty.